INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

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COUNTRY USSR

REPORT [redacted]

SUBJECT Soviet Manuals for Equipment Carried on the MIG-21F-13 Aircraft, Including the ASP-5ND Sight

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THIS IS UNEVALUATED INFORMATION. SOURCE GRADINGS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

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[redacted] Soviet English-language manuals for equipment associated with the K-13 air-to-air missile on the MIG-21F-13 aircraft [redacted] No publishing data are given.

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Attachment No.	Description
1	Temperature Pickup P-5 of Free Air Electric Thermometer, 15 pages.
2	Range Computer VRD-2A, No. 015.99.94, Operating and Maintenance Instructions, 21 pages and 8 pages of figures.
3	Attack and Slip Angles Transmitter Type DUAS-8M, Description and Installation Instructions, 8 pages plus 3 pages of figures.
4	Aircraft Automatic Sight Type ASP-5ND, Technical Description, 292 pages. This sight is employed with the NR-30 cannon, ARS-57M (S-5M) and KARS-57 (S-5K) rockets, and guided missiles US (sic), and may operate in conjunction with the SRD-5MK (KVANT) range-only radar.
5	Overload Warning Unit MP-28A, 24 pages and 6 pages of figures.

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GROUP 1
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STATE	DIA	ARMY	NAVY	AIR	NSA	XXX NIC	OCR	SAC
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TEMPERATURE PICKUP P-5
OF FREE AIR ELECTRIC THERMOMETER

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TEMPERATURE PICKUP П-5
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C O N T E N T S

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I. PURPOSE AND STANDARD EQUIPMENT

Temperature pickup П-5 (Fig.1) is designed for remote measuring of ambient air stagnation temperature complete with the ТНВ-1 indicator or other equipment.

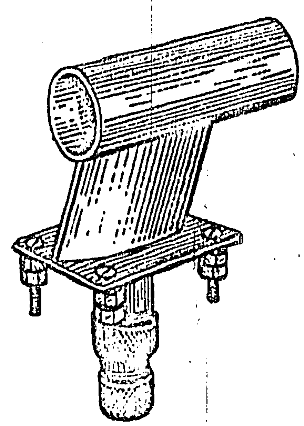

FIG. 1. TEMPERATURE PICKUP. GENERAL VIEW

The set of temperature pickup П-5 includes:

1. Temperature pickup П-5 .... 1 pc
2. Certificate .... 1 copy

II. OPERATION PRINCIPLE

The operation of temperature pickup П-5 is based on properties of metals (nickel wire, in particular) to change electric resistance with temperature fluctuation. Each temperature value measured corresponds to a definite value of electric resistance.

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Electric resistor of the thermal element of the temperature pickup is disposed at the narrow section of the pickup (Fig.2) representing a convergent-divergent nozzle. The narrowest section of the nozzle is called critical.

The convergent-divergent nozzle possesses the following property: an airflow running at a subsonic speed is accelerated in the convergent section and decelerated in the divergent section whereas a supersonic airflow is decelerated in the convergent section and accelerated in the divergent section.

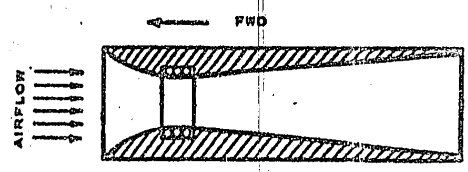

FIG. 2. TEMPERATURE PICKUP DIAGRAM

Consequently, the operation of the temperature pickup is based on that during the flight the air enters the pickup confuser (convergent section of the nozzle), and since the moment the airflow speed equals $M = 0.5$ (M number equals the ratio of flight speed V to sound speed a, i.e. $M = \frac{V}{a}$), irrespective of further speed increase, at the convergent critical section of the pickup critical conditions set up, which are characterized by the sound local speed.

In critical conditions the ratio of the temperature, sensed by the thermal element of the pickup, to the temperature of completely stagnated airflow is a constant value which equals

$$\frac{T_T}{T_0} = 0.978,$$

where T_T is a temperature, sensed by the pickup thermal element, expressed in degrees of absolute scale ($^{\circ}K$), i.e. $T_T = t_T + 273^{\circ}$ (t_T is a temperature, sensed by the pickup thermal element, expressed in $^{\circ}C$);

T_0 is a temperature of completely stagnated airflow expressed in degrees of absolute scale ($^{\circ}K$), i.e.

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$T_o = t_o + 273^o$ (t_o is a temperature of completely stagnated airflow expressed in ^oC).

Stagnation temperature is a temperature of gas or air at a critical point, i.e. at the point of an object at which air speed equals zero.

Conversion of kinetic energy into potential one (enthalpy) and vice versa may occur as a result of compression or expansion of the airflow in the narrowing or widening air duct.

The kinetic energy of the flow converts into the potential energy (enthalpy), and the air temperature becomes equal to the stagnation temperature.

Thus, the temperature of the air at the critical section is not equal to the temperature of the undisturbed airflow, and exceeds it by value AV^2 which depends on the speed of the incoming airflow.

The air temperature at the critical section is referred to as stagnation temperature T_o

$$T_o = T_{true} + AV^2,$$

where AV^2 is a dynamic addition to the temperature;

$A = \frac{k-1}{2kgR}$;

T_{true} is a true temperature of the air in degrees of absolute scale (^oK).

Besides, the cause of flow stagnation and temperature rise of the air streaming over objects is air (gas) viscosity. Due to the air viscosity a thin boundary layer of stagnated air is formed at the surface of streamlined objects.

In the boundary layer speeds change from zero (at the surface of the pickup thermal element) to the sound critical speed value.

Owing to the difference in speeds in the contiguous air layers in the vicinity of the thermal element walls, internal friction arises which causes liberation of a great amount of heat in to the boundary layer. One part of liberated heat dissipates in the ambient air, and is carried away by the flow while the other part stays in the boundary layer proper.

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Through the equilibrium established between heat liberation caused by internal friction in the air and heat dissipation in the ambient air the boundary layer has a certain temperature which is higher than that of the incoming airflow.

Thus, the temperature of the air which comes in contact with the surface of the thermal element is rather close to stagnation temperature T_0.

The stagnation temperature can be expressed in terms of a Mach number.

$$T_0 = T_{true} \left(1 + \frac{k-1}{2} M^2\right),$$

where k is an adiabatic index (non-dimensional value); for air $k = 1.4$ and, consequently,

$$T_0 = T_{true} \left(1 + 0.2\, M^2\right).$$

Temperature T_T sensed by the pickup thermal element equals stagnation temperature T_0 multiplied by quality factor N of the pickup, i.e. $T_T = T_0 N$.

Quality factor N of the pickup indicated in the Chart (Fig.3) depends on Mach number at low flight speeds only, i.e. up to $M = 0.5$.

From flight speed $M = 0.5$ and up, the value of factor N is constant (0.978) and does not depend on the further speed increase.

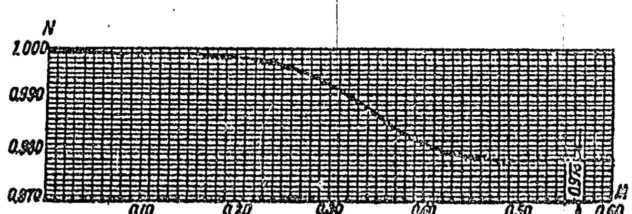

FIG. 3. PICKUP QUALITY FACTOR N VES MACH NUMBER

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The pickup measures the airflow temperature sensed by its thermal element

$$t_T = (t_o + 273)N - 273^oC.$$

To determine a true temperature of the ambient air, the following expressions may be used

$$T_{true} = \frac{T_T}{N\,(1 + 0.2\,M^2)} \quad ^oK$$

or, in ^oC,

$$t_{true} = \frac{t_T + 273}{N\,(1 + 0.2\,M^2)} - 273^oC.$$

Quality factor N is defined from the Chart (Fig.3) depending on the M number determined instrumentally. Quality factor N is calculated theoretically and is proved experimentally.

The above expressions show that on the ground, when the flight speed M = 0 (quality factor N = 1), the pickup measures true temperature of the ambient air.

III. CONSTRUCTION

Temperature pickup П-5 (Fig.4) designed to measure ambient air temperature is non-detachable in construction; it consists of the following basic components: thermal element 2, housing 6, diffuser 1, confuser 3 and plug connector 7.

The thermal element is a cylindrical frame, made of copper, on which insulated nickel wire, dia.0.05 mm, is wound. Series-connected to the nickel winding is winding 5 made of insulated constantan wire, dia.0.08 mm, wound on two insulating plates 4.

The constantan winding is intended for adjusting the temperature coefficient of the thermal element.

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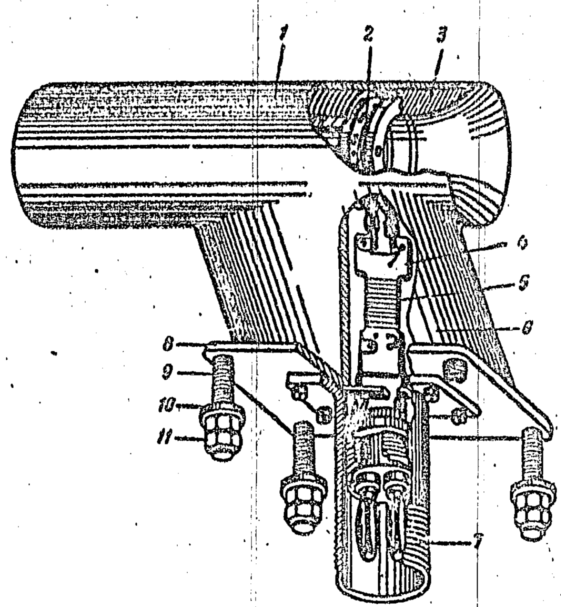

FIG. 4. CONSTRUCTION OF TEMPERATURE PICKUP П-5
1 – diffuser; 2 – thermal element; 3 – confuser; 4 – insulating plates; 5 – constantan wire; 6 – housing; 7 – plug connector; 8 – flange; 9 – fastening screws; 10 – washers; 11 – nuts.

IV. BASIC SPECIFICATIONS

1. The pickup measuring range is from −60 to +150°C. The operating range is from −40 to +130°C.

2. The error of the pickup in the operating range does not exceed ±1.5°C.

3. The time constant of the pickup does not exceed 3 sec at an airflow speed of at least 50 m/sec.

4. The pickup withstands vibration acceleration of 4 g within the frequency range of 40 to 80 c.p.s.

5. Current flowing through the winding of the pickup thermal element should not exceed 30 mA.

6. The pickups are respectively interchangeable.

7. The pickup weight – not over 250 gr.

V. ASSEMBLING

After unpacking, the pickup should be examined to make sure that its housing is not damaged.

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The diffuser and confuser of the pickup are made of plastic and should be carefully handled; the edge of the diffuser should be prevented against shocks.

Prior to installation on the aircraft, check the pickup for proper operation, for which purpose connect it to the THB-1 indicator in compliance with the wiring diagram (Fig.5).

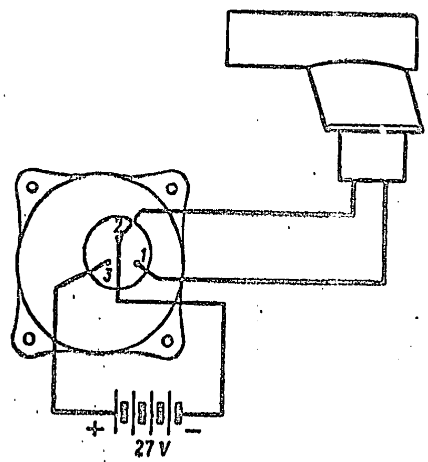

FIG. 5. WIRING DIAGRAM

In this case the indicator should read the temperature equal to that of the ambient air, which testifies to the pickup serviceability.

If the THB-1 indicator is not available check the pickup for proper operation by measuring the electric resistance of the thermal element winding with a Wheatstone bridge.

The temperature measured by the pickup can be determined by the value of the electric resistance of the thermal element winding given in Table 1.

Table 1

Pickup Thermal Element Electric Resistance Versus Temperature

°C	Ohm	°C	Ohm	°C	Ohm
1	2	3	4	5	6
-60	70.90	15	95.40	90	125.40
-55	72.30	20	97.20	95	127.60

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1	2	3	4	5	6
-50	73.70	25	99.06	100	129.80
-45	75.20	30	100.90	105	132.02
-40	76.70	35	102.80	110	134.25
-35	78.25	40	104.70	115	136.52
-30	79.80	45	106.67	120	138.80
-25	81.40	50	108.65	125	141.10
-20	83.00	55	110.63	130	143.40
-15	84.70	60	112.62	135	145.80
-10	86.40	65	114.71	140	148.20
-5	88.25	70	116.80	145	150.65
0	90.10	75	118.93	150	153.10
5	91.85	80	121.06		
10	93.60	85	123.23		

A. Pickup Assembly

The pickup is installed on the aircraft so that the airflow to be measured enters the opening of the pickup confuser (See Figs 2 and 4).

The pickup is fastened to an appropriate part of the aircraft through flange 8 by means of four screws 9 with nuts 11 and washers 10 (Fig.4). The pickup should be mounted so as its axis is parallel to the longitudinal axis of the aircraft.

The red arrow on the pickup flange should be pointed in the direction of the aircraft flight.

Overall dimensions of the pickup are given in Fig.6.

B. Wiring

The pickup is connected to the indicator, recorder or respective instrument through a wire, mark ЕМВЛ, 0.75 - 1 sq mm.

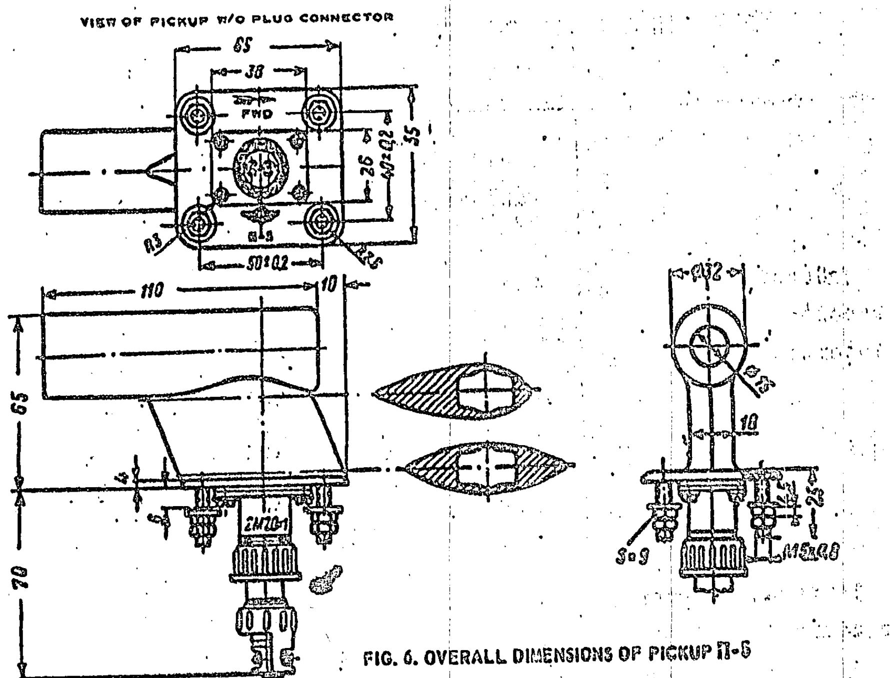

FIG. 6. OVERALL DIMENSIONS OF PICKUP П-6

VI. TROUBLES AND REMEDIES

Trouble	Cause	Remedy
1	2	3
Indicator pointer is at initial point of scale. Indicator does not operate	No power supply or faulty switch	Switch on power supply or repair switch
	Broken supply wire	Repair or replace broken wire
	Faulty indicator	Replace indicator
	Faulty recorder	Repair or replace recorder
Indicator pointer overshoots scale	Broken connection wire	Repair or replace wire
Recorder pen deviates to extreme right	Faulty pickup	Replace pickup

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1	2	3
	Faulty indicator	Replace indicator
	Faulty recorder	Repair or replace recorder
Indicator or recorder operates intermittently	Poor contact of wires	Repair or replace wire
	Faulty switch	Replace switch
	Faulty pickup	Replace pickup
	Faulty indicator	Replace indicator
	Faulty recorder	Repair or replace recorder
Temperature wrong reading	Faulty pickup	Replace pickup
	Faulty indicator	Replace indicator
	Faulty recorder	Repair or replace recorder

In all cases the pickup fails to operate through the Manufacturer's fault before the guaranteed service life has expired, send back the faulty pickup complete with the Certificate and an appropriate statement for replacement.

VII. MAINTENANCE

When in service, check the pickup every 50 flying hours, as well as prior to its installation on the aircraft in case the pickup was stored for more than three months; check it following the procedure given below:

A. Error check.

B. Insulation resistance check.

Besides, regularly check the pickup and its plug connector for proper fastening.

Should the pickup read inaccurately, it must be replaced with a new one checked and serviceable.

Every 10 flying hours and at least once a month check the inside surface of the pickup for cleanliness.

If dirt or dust is found inside the pickup, clean the inner surface of it with a piece of soft cloth or with a downy brush. Do this with care so as to avoid notches and damage to the inside surface of the pickup and, particularly, of thermal element 2 (See Fig.4).

VIII. TEST PROCEDURE

A. Error Check

Pickup error test is carried out on the ПУТ-48 or УПТ-11 test set.

Brief Description of Pickup Check

With selector switch П_1 (Fig.7) turned to the contacts position 3-3, power supply is delivered to the pickup check circuit.

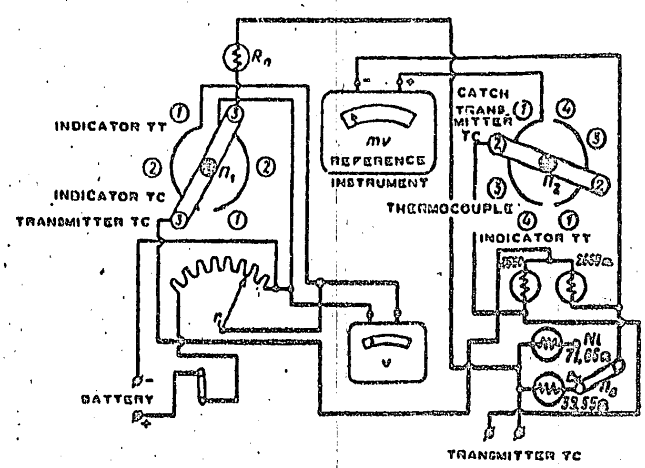

FIG. 7. PICKUP CHECK CIRCUIT

This portion of the circuit contains the unbalanced bridge one arm of which is the pickup under test.

An indicating instrument is a reference instrument whose dial is graduated in ^{o}C.

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Turning the handles of selector switch П_2 to the contacts position 2-2 switches the reference instrument into the bridge diagonal.

Test Procedure

1. Connect the temperature pickup under test to terminals TRANSMITTER TC (ДАТЧИК ТС) of the test set.

2. By turning handle REFERENCE INSTRUMENT DIALS SWITCH (ПЕРЕКЛЮЧАТЕЛЬ КОНТРОЛЬНОГО ПРИБОРА), match index −50°C of the dial, which graduation corresponds to that of the pickup under test, with the pointer of the reference instrument.

3. Set the handle of selector switch П_6 bearing inscriptions Ni and Cu to position Ni.

4. Set the handle of selector switch П_1 to position TRANSMITTER TC.

5. Set the handle of selector switch П_2 to position TRANSMITTER TC.

6. Turn on power supply by setting the switch to the ON (ВКЛЮЧЕНО) position.

7. Set 27 V on the reference voltmeter by turning handle VOLTAGE CONTROL (РЕГУЛИРОВКА НАПРЯЖЕНИЯ) of rheostat r_1.

8. Place the pickup under test together with a mercury thermometer (graduated in 0.1°C) in the air chamber with a constant temperature keeping the air motionless.

9. After a ten-minute interval take the reading off the reference instrument.

10. The difference in readings of the measured true temperature of the pickup and that of the reference instrument will be equal to the sum of the errors of the pickup under test and the error of the test set in °C.

Accuracy of the test set readings is ±1% of the dial rated value at an ambient temperature of +20°C.

B. Insulation Resistance Check

Insulation resistance of the pickup is checked with a megohmmeter rated at 500 V.

Insulation resistance is measured between the plug connector terminals coupled together and the pickup flange.

The value of insulation resistance depends on air humidity. At air relative humidity up to 80% and normal temperature of $20 \pm 5^{\circ}C$ it should be at least 20 megohms, and at air relative humidity of 95% - at least 2 megohms.

IX. UNPACKING AND STORAGE

In receiving the boxes with temperature pickups П-5, make sure that package is good. If the package is damaged, draw up a statement and send claims to the transportation agency.

In winter unpack the boxes in warm premises only.

To prevent moisture from getting onto the equipment do not open the boxes unless the temperature of the instruments is equal to that of the ambient air. Open the boxes 2 - 3 hours after they have been carried indoors.

In summer the boxes may be opened right away on their receipt.

Unpacking should be performed in the following sequence:

(a) open the box with care (the box cover bears the inscription "Up");

(b) take cartons with pickups out of the boxes and unpack them. Take out the Certificates for the pickups and put them into the Service Logs.

The pickup having no Certificate is not allowed to be installed;

(c) visually inspect the pickup with care. If during the unpacking defects are detected, draw up an appropriate statement.

Store the pickups on racks in dry ventilated premises at +10 to $+35^{\circ}C$ and relative humidity of 80%. No corrosion conditions, shocks and vibrations are allowed.

It is recommended to store the pickups in shop-made package. Do not place one pickup on another if without package.

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RANGE COMPUTER M [illegible]

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RANGE [illegible]

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C O N T E N T S

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I. PURPOSE

The range computer, type ВРД-2А, serves to produce a voltage proportional to $\Delta V_{cp} = f(\frac{V_H}{H})$ for a range finder, type СРД.

Note: Further in the text the range computer, type ВРД-2А, will be termed "computer".

II. SET

The computer set consists of a unit presented in Fig.1 and a special screw-driver.

In the СРД system the computer is used to produce voltages to be summed up with the close-up speed. It operates from a signal of the ДВС-5 air speed transmitter which incorporates a temperature gauge, type П-5.

III. SPECIFICATIONS

1. Power supply.................. D.C. 27 V ± 7%; D.C. 25 - 30 V with setting accuracy of ± 0.1 V; A.C. 36 V ±5% 400 c/s ± 2%
2. Altitude range................ 0.5 - 25 km.
   True air speed range.......... 300 - 2500 km/hr
   Indicated air speed range..... 300 - 1500 km/hr
   Permitted range............... 0.275 - 11.8 km.
   $\frac{V_H}{H}$ ratio range............... 50 - 350 1/hr
3. Output voltage accuracy....... ± 4.5% at t = 20°C; ± 5% at t = -60°C and t = + 60°C
   An accuracy of ± 5.5% is permissible when the ВРД-2А unit is coupled with the ДВС-5 and П-5 devices

An accuracy of ± 10% is permissible at the altitude of 1.5 km., speed of V = 525 km/hr in the temperature range from − 60°C to + 60°C

4. Vibration resistance......... computer is vibration-proof in the frequency range from 20 to 200 c/s and acceleration of 4 g
5. Power consumed............... D.C. − 10 W, max.
   A.C. − 12 VA, max.
6. Output potentiometer impedance.................... 10,000 ohms
7. Weight....................... 2200 gr, max.

IV. OPERATION PRINCIPLE

Permitted range is determined as follows:

$$Д_p = 3.06 \times 10^{-3} \left[\Delta V_{cp}(V_H, H) + Д\right] \text{km.},$$

where $Д_p$ − permitted range;

ΔV_{cp} − true air speed and altitude function;

V_H − true air speed at altitude H;

H − flight altitude;

$Д$ − close-up speed.

The ДВС-5 transmitter produces a voltage proportional to the true air speed and the computer proper produces a voltage proportional to the flight altitude. Both voltages are converted by the computer to a voltage proportional to $\Delta V_{cp} = f\left(\frac{V_H}{H}\right)$ (See Fig.2).

The voltage proportional to Д according to $U_Д = 0.04\,Д$ is introduced by the СРД.

Since V_H and H are the functions of the static and dynamic pressures, the computer is built up on a barometric principle.

V. KEY CIRCUIT DIAGRAM

The computer is a potentiometer-type calculator being built up as a self-balancing bridge circuit, formed by potentiometers Π_4, Π_6, and Π_7 (See Fig.3).

The output voltage of potentiometer Π_4 (considering potentiometer Π_6 load) is a function proportional to the true air speed:

$$U_1 = f_1 (V_H).$$

The voltage produced by potentiometer Π_6 is a function inversely proportional to the altitude:

$$U_2 = f_2 \left(\frac{1}{H}\right).$$

Potentiometers Π_4 and Π_6 form a multiplier circuit, therefore, potentiometer Π_6 produces voltage proportional to $V_H \times \frac{1}{H}$ which is defined as follows:

$$U = U_1 \times U_2 = f_1 (V_H) \times f_2 \left(\frac{1}{H}\right) = f_3 \left(\frac{V_H}{H}\right).$$

Voltage U actuates potentiometer Π_7 by means of a magnetic amplifier and an electric motor, type ДИД-0,5. This operation is performed as follows: wipers of potentiometers Π_6 and Π_7 are connected to the magnetic amplifier input so that the potentiometer input voltage equals zero, if the potential difference between the circuit input and potentiometer Π_7 wiper equals the potential difference between the circuit output and potentiometer Π_6 wiper. In this case the magnetic amplifier input voltage equals zero, the ДИД-0,5 control winding voltage also equals zero, and as a result the wiper of potentiometer Π_7 fails to move.

The key circuit diagram of the magnetic amplifier is presented in Fig.13.

If the voltage produced by potentiometer Π_6 or Π_4 is changed, some voltage appears at the amplifier input. This voltage is amplified and fed to the ДИД - 0,5, which moves potentiometer Π_7 wiper through reductor P until circuit balance is restored, i.e. until the potential difference between the input and potentiometer Π_7 wiper equals the potential difference between the output and potentiometer Π_6 wiper.

Potentiometers Π_7 and Π_8 wipers are located on a common axle. Potentiometer Π_8 serves to produce a voltage proportional to

$$\Delta V_{op} = f\left(\frac{V_H}{H}\right).$$

Since potentiometer Π_8 has a linear characteristic, its output voltage is also proportional to

$$\Delta V_{cp} = f\left(\frac{V_H}{H}\right).$$

According to the key circuit diagram (Fig.4) the voltage from the aircraft D.C. 27-V mains is fed to terminals 7 and 6 of plug connector $Ш_3$ of the computer. Positive voltage + 27 V is fed to terminal 4 of block A, and then to resistors R_{95} and R_6. Negative voltage - 27 V is fed to terminal 6 of plug connector $Ш_3$ terminal 5 of block A and resistor R_{36} in (input). A.C. 36 V, 400 c/s from the inverter, type ПАГ-1Ф or ПТ is fed to terminals 8, 10, and 12 of plug connector $Ш_3$ (Fig.4) to supply the magnetic amplifier and the ДИД-0,5 motor exciting winding. Output potentiometer Π_8 of the computer is fed by a regulated voltage of 25 - 30 V (with an accuracy of ± 0.1 V) from the СРД unit through terminals 1 and 5 of plug connector $Ш_3$. Voltage supply from potentiometer Π_8 wiper to the СРД unit is accomplished through terminal 9 of plug connector $Ш_3$.

D.C. 27 V is fed through absorbing resistor R_6 (in the computer circuit) and terminal 13 of plug connector $Ш_3$ to terminal 1 of plug connector $Ш_2$ (in the П-5 stagnation temperature gauge circuit) and, on the other hand, to terminal 7 of plug connector $Ш_1$ in the ДВС-5 transmitter.

In the computer provision is made for resistors R_5, R_6, and R_8 which are necessary to ensure operation of the computer in conjunction with the ДВС-5 transmitter.

Resistor R_5 serves to regulate scale speed. Resistor R_6 is an absorbing resistor in the П-5 gauge circuit.

Resistor R_8 serves to reduce voltage supplied to the magnetic amplifier of the ДВС-5 transmitter down to 18 V.

Resistors R_7, R_4 and potentiometer Π_6 constitute a load of 121.5 ohms. Resistor R_{36} is used to ensure the circuit

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balance and is connected between potentiometer $П_7$ in (input) and terminal - 27 V.

Potentiometer $П_8$ is a high-resistance one (10 kilohms) and serves to introduce a signal to the СРД system.

Shunts and additional resistors in potentiometers $П_6$, $П_7$, and $П_8$ are used to collect voltage from these potentiometers in a certain relationship.

In the computer use is made of a two-stage magnetic amplifier.

Principle of operation of the two-stage magnetic amplifier (Fig.13) is based on the property of the core material to reduce permeability under the action of the actuating signal (magnetization). With the input signal fed to control windings W_y, the current in feedback windings W_{oo} of one coil increases and in feedback windings W_{oo} of the other coil decreases. The same takes place in windings $W_{\sim 1}$ of both coils. As a result, unbalance of the differential arms of the first stage is created. Voltage of the unbalance is fed to the input bridge consisting of four windings and is amplified once more due to current difference in windings W_{y2} of the second stage. Thus, an output voltage appears at the amplifier. Resistors R_{20} and R_{21} serve to regulate the zero and amplification coefficient of the amplifier. Temperature is being compensated by copper resistor R_{19M} and constantan resistor R_{19k}. Choke Дp is installed to reduce supply voltage of the first stage from 36 V down to 14 V.

VI. CONSTRUCTION

The computer (Fig.1) consists of the following parts:

(a) altitude unit 1;

(b) follow-up unit 2;

(c) mounting support with amplifier 3.

Altitude unit is mounted in a hermetic housing, whose inner cavity communicates with the Pitot-static tube.

A stack of sealed bellows 2 serves as the sensitive element of the altitude unit (See Fig.5). The stationary

centre of the stack is fixed onto frame 1 and the movable one is connected to axle 11 by means of hinge 3, rod 9 and link 10. Besides, this axle mounts wiper holder 4 with wipers 5.

Terminal block 6 is fastened to frame 1 by screws 12, 13. This block carries potentiometer 8 and by-pass coils 7 as well. By-pass coils 7 are mounted onto pins which serve as terminals for soldering coils to corresponding sections of the potentiometer.

The housing pressurization is ensured by tightening cover 15 with the aid of screw collar 16.

Hookup wires are led out through sealed terminals 17 located in the bottom of the housing.

<u>Follow-up unit</u> is an independent system which consists of an electric motor with a reductor, a potentiometer unit, set of by-pass coils and switching elements for connecting the computer to the ДВС-5 and П-5.

The outer view of the follow-up unit is shown in Fig.7.

There are two ring-type potentiometers in the potentiometer unit (See Fig.8): one of them - follow-up potentiometer 1 and the other (2) is an output one. They are mounted on frame 6 of the follow-up unit.

ДИД-0,5 electric motor 4 and reductor 5 are mounted on the base of frame 6.

Common wiper holder 7 and current-carrying springs 8 are located on the axle which rotates on the bearings of plates 9.

By-pass coils 10 are mounted onto pins 11 of terminal block 13. The pins serve to connect by-pass coils 10 to corresponding sections of the follow-up potentiometer.

Adjustable rheostat 15, A.C. absorbing resistor 16, load resistor 17, absorbing resistor 18, circuit balancing resistor 19 and terminal blocks 20 are located on base plate 14, which is fastened to frame 6 by means of screws.

The follow-up unit is covered by housing 12 and is fixed in the recess of the altitude unit housing by screws.

The hookup wires of the follow-up unit and the hookup wires of the altitude unit are bunched together constituting one bunched conductor 21 and are connected to the plug connector of the mounting support.

The scale of the follow-up unit is graduated in $\frac{V_H}{H}$ (1/hour).

Mounting support with the amplifier is also an independent unit (See Fig.9). The mounting support serves to mount the ДВС-5 transmitter and to couple it with the magnetic amplifier.

The mounting support consists of plate 1 and panel 5. Fastened to the bottom of plate 1 by means of four nuts 3 is magnetic amplifier 2. The upper side of this plate mounts the transmitter which is fixed by screws 18 and metallic strips.

Riveted to the plate end face is block 20 which is connected to a cable with type 2РМ24Б19Ш181 plug connector 21.

Plate 1 on which the transmitter and the amplifier are mounted is attached to panel 5 by screws 6 and four pairs of shock absorbers 22, types 271С-49-1-1 and 271С-49-1-2, which ensure the instrument vibration resistance.

Four rubber washers 8 attached to the lower shock absorbers by screws 6 and nuts 9 protect the equipment against impact load. There are four slots to attach mounting support 5 to the shock absorbers.

Magnetic Amplifier

(Fig.10)

The magnetic amplifier is mounted in housing 1; it consists of:

(1) two toroidal chokes 2 of the first stage;
(2) two chokes 3 with three-leg cores of the second stage;
(3) two selenium rectifiers 4;
(4) absorbing choke;
(5) condenser, type МБГП (0.5 μF);
(6) adjustable rheostat 6;
(7) two adjusting resistors;
(8) МЛТ-0,5 resistor 7.

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Toroidal choke 2 has a core composed of a set of rings made of permalloy, grade 79НМ, 0.35 mm thick. This permalloy ring set is inserted into a special aluminium holder which prevents mechanical damage to the core during winding of the coil and compensates ambient temperature changes.

The holder is wrapped with varnished cambric which carries the A.C. winding. Two such cores with A.C. windings are put together and wrapped with varnished cambric. A feedback winding and an input winding insulated from one another are wound onto the paired core. The coils are insulated from one another.

The choke core of the second stage is composed of Ш-type plates made of steel, grade Э-44.

Absorbing choke 5 consists of a spool with winding (wire, type ПЭВ-2, ∅ 0.15) and a core composed of Pi-shaped plates made of steel, grade Э-44.

Selenium rectifier 4 consists of five selenium plates and five spring washers fixed on a stud. The rectifier is filled with a compound to ensure isolation of the selenium plates from the ambient air.

Adjustable rheostat 6 is wound of constantan wire, mark ПЭК, ∅ 0.15, with 50 - 60 ohm resistance.

Wire leads of the magnetic amplifier are bunched together and connected to the common block attached to the mounting support.

VII. MAINTENANCE AND OPERATION

1. Preinstallation Check

Prior to installation, the computer should be connected to the ДВС-5 and П-5 according to the connection circuit diagram for the ДВС-5 and the ВРД-2А (See Fig.11).

1. Supply the voltage indicated in the computer Certificate to terminals 1 and 5 of plug connector Ш3.

2. Set the power source to supply A.C. 36 V ± 5%, 400 c.p.s. ± 2% and D.C. 27 V ± 7%.

3. See to it that appropriate velocity head ΔP and static pressure P (See Table 1) are created in the range required for the computer and the ДВС-5 check, making use of the pneumatic installation shown in Fig.14.

Table 1

H	P	V	ΔP	Output voltage in V, at ambient temperature in °C as read by the II-5 temperature gauge													Tolerance
km.	mm Hg	km/hr	mm Hg	− 60	− 50	− 40	− 30	− 20	− 10	0	+ 10	+ 20	+ 30	+ 40	+ 50	+ 60	%
1.5	636.5	525	85.5	5.9	5.7	5.6	5.4	5.3	5.2	5.2	5.1	5.0	5.0	5.0	5.0	5.0	10
2	598.4	500	72.3	9.2	9.1	8.9	8.8	8.7	8.3	8.2	8.1	7.9	7.8	7.6	7.3	7.2	5.5
4	463.9	1200	483.9	7.7	7.4	7.2	6.9	6.8	6.6	6.3	6.2	5.9	5.8	5.6	5.5	5.4	5.5
5	406.5	1000	250.8	12.0	11.6	11.4	11.2	10.9	10.6	10.4	10.1	10.0	9.8	9.7	9.5	9.4	5.5
8	267.9	1200	279.5	15.7	15.4	15.1	14.8	14.6	14.3	14.1	13.9	13.6	13.4	13.2	13.0	12.8	5.5
10	198.9	1000	122.7	20.4	20.2	19.9	19.7	19.4	19.0	18.8	18.7	18.4	18.3	18.1	17.9	17.6	5.5
20	41.1	1600	109.4	23.2	22.9	22.7	22.4	22.2	21.9	21.7	21.4	21.2	21.0	20.9	20.8	20.7	5.5
25	18.7	1500	39.9	27.0	26.4	26.1	25.8	25.7	25.3	25.0	24.9	24.6	24.5	24.3	24.2	24.0	5.5
25	18.7	2500	476.9	20.4	20.2	19.9	19.7	19.4	19.0	18.8	18.7	18.4	18.3	18.1	17.9	17.6	5.5

Appropriate ΔP and P are set according to Table 1 and U_{out} value is determined depending on the ambient temperature read by the П-5 gauge.

For this purpose a high-resistance voltmeter with internal impedance of 100 kilohms is connected to pins 5 and 9 of plug connector $Ш_3$ (it is recommended to make use of device Ц-51 or installation ППТВ-1).

The computer error is determined as follows:

$$\delta = \frac{U_{calc} - U_{meas}}{U_{calc}} \times 100\%,$$

where δ – error at a given value of ΔV_{cp};

U_{calc} – calculated value of ΔV_{cp} in volts;

U_{meas} – measured value of ΔV_{cp} in volts.

If the errors exceed the permissible values, it is recommended to vary the true air speed signal, making use of rheostat R_5 included in the computer circuit, thus increasing or decreasing the computer $\frac{V}{H}$ readings.

<u>Notes</u>: 1. If the attempts to adjust the ВРД-2А computer connected to the ДВС-5 and the П-5 by means of the rheostat give no effect, an additional adjustment is permitted by supplying a voltage of 25 – 30 V to the ВРД-2А output potentiometer. It should be registered in the computer Certificate?

2. Rheostat R_5 slider should be displaced by means of a screw-driver furnished with the ВРД-2А computer.

When using the ВРД-2А computer in conjunction with the ДВС-5 and П-5, the number of the ДВС-5 transmitter should be registered in the computer Certificate.

This done, check the computer operating in conjunction with the СРД system in accordance with Instructions on the СРД and the computer coupling.

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Note: Instructions on checking the ВРД-2А operation in conjunction with the СРД are included in the СРД description and are also given in the present Instructions.

2. Installation Requirements

The computer is mounted on a shock-absorbing base in any suitable site of the aircraft, provided the following requirements are met:

1. The computer scale should be easily observed during check.
2. The shock-absorbing base should be in horizontal position during flight.
3. Vibration acceleration at the computer attachment place should be in compliance with the computer Specifications.
4. The computer installation place should be selected so as to ensure the most convenient connection of the computer pipe union to the ПВД static system. It is desirable that this installation place should be above the ПВД system.

   Provision should be made for a moisture trap and a drainage system to protect the equipment against moisture.
5. Pneumatic line connection should be sealed according to the aircraft pneumatic line standards.
6. Provision should be made for the equipment free movement on the shock-absorbers to protect it from impacts against adjacent objects.
7. The equipment cable and pneumatic hose should be attached to the fuselage in such a way as to provide the computer free travel and self-setting (without hose tension).
8. The computer connection to the ДВС-5 and the П-5 should be performed in accordance with the ДВС-5 and the ВРД-2А cable connection diagram (See Fig.11).

Note: All the computer installation requirements concern also the ДВС-5 transmitter.

Installation and overall dimensions of the computer are shown in Fig. 12.

9. The П-5 should be installed on the fuselage in accordance with the requirements for stagnation gauge installation.

3. Postinstallation Check

1. Check the computer for proper installation.
2. Check the pneumatic lines for airtightness.
3. Check the computer connected to the ДВС-5, П-5 and СРД for serviceability.

4. Preflight Check

1. Check visually the computer for intactness, its connection to the ДВС-5, the П-5; check the ДВС-5 and П-5 for proper attachment; the electric wiring continuity and the plug connectors serviceability.

2. Check the computer connected to the ДВС-5, П-5, and СРД for serviceability.

5. Scheduled Maintenance Operations

Checking after 10 hours of operation (minimum once every month).

Perform the preflight checking.

Checking after 25 hours of operation (minimum once every 3 months).

Perform the 10-hour scheduled maintenance operations.

Check the pneumatic lines for airtightness.

Checking after 50 hours of operation (minimum once every 6 months).

Perform the 25-hour scheduled maintenance operations.

Check the computer accuracy during its operation in conjunction with the СРД.

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6. Checking Procedure

(a) Installation Check

When checking the equipment for proper installation, it is necessary to examine attachments of the ВРД-2А, ДВС-5, and П-5 to the aircraft structure and to make sure that all the installation requirements are met.

(b) Pneumatic Lines Airtightness Check

The airfield installation, type КПУ-3, used for testing air-speed indicators should be connected to the ПВД Pitot-static tube coupled with the ВРД-2А and the ДВС-5. Then the pneumatic lines of the ВРД-2А operating with the ДВС-5 are checked for airtightness in accordance with aircraft pneumatic lines standards.

(c) Checking Computer Serviceability on Board Aircraft

The computer serviceability is checked by actuating it together with the ДВС-5, the П-5, and the СРД as follows:

1. Switch on toggles RANGE FINDER (РАДИОДАЛЬНОМЕР) and ВРД-2А.

2. Connect the high-resistance voltmeter to check terminals C and OUT of unit 8 of the range finder.

3. Using the КПУ-3 airfield installation introduce an altitude of 1 - 2 km. to the computer and the ДВС-5 transmitter through the ПВД static vents, the ПВД dynamic vent remaining open. In this case the scale of the computer should begin to rotate counter-clockwise until maximum value of $\frac{V_H}{H}$ is reached. The voltmeter reading should reduce from 27 V to ~5 V.

Reducing the altitude to zero make sure that the computer scale moves in the direction of reduction of the $\frac{V_H}{H}$ values, and the voltage on terminals C and OUT of range finder unit 8 increases from ~5 V to 27 V.

The check over, switch off toggles RANGE FINDER (РАДИОДАЛЬНОМЕР) and ВРД-2А.

(d) Checking ВРД-2А Accuracy during Operation Together with ДВС-5, П-5 and СРД on Board Aircraft

1. Set an altitude of 5 km. by the КПУ-3 through the ПВД static vents. The dynamic vent of the ПВД remains open. Prior to this, set the day ambient air pressure and the altitude above sea level on the reference altimeter by a rack. This altitude should correspond to the day ambient air pressure considering the altimeter corrections (See Note 3 of Item 2 below).

Check the voltage between the C and OUT terminals of range finder unit 8. It should be within 8.7 ± 0.56 V.

2. Set an altitude of 10 km., conditions being similar to those listed in Item 1.

The voltage between terminals C and OUT of СРД unit 8 should be within 12.9 ± 0.6 V.

Note 1. The ВРД-2А check in accordance with Items 1 and 2 is valid only at the ambient air temperature of + 20° ± 2°C as read by the П-5 gauge. At any other ambient temperature make use of the following Table.

Table

for Checking the ВРД-2А at Various Ambient Temperatures as Read by the П-5

Ambient temperature as read by П-5 gauge	Voltage should be rated for altitude H = 5 km.	Voltage should be rated for altitude H = 10 km.
1	2	3
- 60	9.8 - 10.9	13.9 - 15.3
- 50	9.5 - 10.6	13.6 - 15.1
- 40	9.5 - 10.5	13.5 - 14.9
- 30	9.3 - 10.3	13.1 - 14.5
- 20	9.0 - 9.9	12.9 - 14.3

1	2	3
- 10	8.8 - 9.7	12.8 - 14.1
0	8.7 - 9.6	12.5 - 13.9
+ 10	8.6 - 9.5	12.4 - 13.7
+ 20	8.2 - 9.1	12.3 - 13.5
+ 30	8.1 - 9.0	12.2 - 13.4
+ 40	8.0 - 8.9	11.5 - 12.8
+ 50	7.8 - 8.6	11.2 - 12.4
+ 60	7.7 - 8.5	10.9 - 12.1

2. The ДВС-5 and ВРД-2А scales are reference ones and serve only to determine general serviceability of these units.
3. If the day ambient air pressure does not equal 760 mm Hg when setting the altitude by the reference altimeter (ВД-20), it is necessary to make use of the following Table:

Day ambient air pressure set by rack of ВД-20, mm Hg	Readings fixed at altitude H = 0 by rack of ВД-20	Altitude set by ВД-20 (for H = 5 km.) m.	Altitude set by ВД-20 (for H =10 km.), m.
790	- 330	4500	9100
[illegible]	- 200	4700	9400
770	- 100	4830	9700
762.76	0	5000	10,000
750	+ 100	5200	10,380
740	+ 200	5400	10,700
730	+ 330	5500	11,100

For intermediate values of the day ambient air pressure (Column 1), intermediate values for magnitudes in Columns 2,3, and 4 should be determined.

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EXAMPLE: The day ambient air pressure is 790 mm Hg. Checking is performed for H = 5 km.

Set an altitude of 330 m. by the knob of the ВД-20 altimeter and set the bigger pointer to position 670 m. moving it counter-clockwise.

Slacken the self-locking nut, set the day ambient air pressure (790 mm Hg) by the rack and lock the self-locking nut.

Set a pressure of 4.5 km. on the altimeter and measure the voltage in accordance with Item 1. For the given data the altimeter error is considered to be equal to zero.

Pneumatic Installation Maintenance Instructions

The pneumatic installation consists of elements 2,3,5, 6, 6′, 7, 8, 9, 10, and 11 (See Fig. 14) and serves for altitude and speed simulation in the pneumatic system of the ВРД-2А and the ДВС-5 under test.

Altitude Setting

1. H = 0.

(a) Open cock 7 (cocks 6, 6′, 8, and 9 are closed; cocks 10 and 11 are open) so that the readings of barometer 2 correspond to the atmospheric pressure at the test site. Thereafter cock 7 should be closed.

(b) If the atmospheric pressure at the test site is such that barometer 2 reading sets above H = 0, reduce it down to H = 0 by opening cock 8. This done, close cock 8.

(c) If the atmospheric pressure is such that the barometer reading sets below H = 0, adjust it to read H = 0 by opening cock 6. Thereafter cock 6 should be closed.

2. H ≠ 0.

(a) Open cock 6 (cocks 6′, 7, 8, and 9 are closed, cocks 10 and 11 are open), adjust the reading of barometer 2 to the required altitude and close cock 6.

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When adjusting the reading of barometer 2 to the required altitude maintain pressure using mercury gauge 3 by gradually opening cock 6' .

(b) Reduce the altitude by opening cock 7 (cocks 10 and 11 are open).

Speed Setting

1. H =0.

(a) Open cock 8 (cocks 6', 6, 7, 9, and 10 are closed, cock 11 is open) and adjust mercury gauge 3 reading to the required speed. Thereafter cock 8 should be closed.

(b) Speed reduction is performed by opening cocks 9 and 11.

2. H ≠ 0.

(a) Open cock 8 (cocks 6' , 6, 7, 8, and 10 are closed) and adjust mercury gauge 3 reading to the required speed. Thereafter cock 8 should be closed.

(b) Speed reduction is performed by opening cock 6' .

Altitude Change at Preset Speed

Reduce the preset speed value to zero, using cocks 10 and 11. This done, change the altitude as described above.

7. Faults and Remedies

Fault	Cause	Remedy
1	2	3
1. ВРД-2А fails to operate. With speed introduced, scale does not rotate	(a) Damage in ВРД-2А supply circuit (b) Faulty ВРД-2А	Find damage using ohmmeter and remedy it Check ВРД-2А serviceability in laboratory or in workshop and replace it, if necessary

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1	2	3
2. When switching on, ВРД-2А and ДВС-5 scales rotate up to stops, beyond maximum values of speed and $\frac{V_H}{H}$	(a) D.C. wrong polarity (b) Poor contact in plug connector of П-5 gauge	Change power supply polarity Tighten plug connector of П-5 and remedy wiring, if necessary
3. ДВС-5 fails to operate. With speed introduced, scale does not rotate	(a) Damage in supply circuit (b) Faulty ДВС-5	Find damage and remedy it Check ДВС-5 serviceability in laboratory or in workshop and replace it, if necessary

8. Unit Operation

In flight the computer does not require any adjustment or regulation.

9. Storage

1. The computer should be packed in a special box.

2. The box should be glued by water-proof glue. A printed label should be glued to the end face of the box. The label should contain the following data:

- article name;
- number;
- date of manufacture;
- packager number;
- message number;
- service life;
- article storage life without checking.

[redacted]

3. The box should be placed into a rigid case suitable for transportation by railroad or by truck.

The case should be made of a material with moisture content of not over 15 - 20%.

A spacer made of water-proof paper (bituminous or tar) should be provided between the case and the box.

4. The box should tightly fit the case to prevent the box shifting during transportation.

5. Two outer sides of the case should carry the following inscriptions: HANDLE WITH CARE, DO NOT DROP, THIS SIDE UP and OPEN HERE.

6. The unit should be stored in a special room at a temperature of 20 - 10°C and relative humidity of 60 ± 20%.

There should be no chemical reagents in the room which might cause damage to the article.

Fig. 1. Range Computer, Type [illegible]-2 A

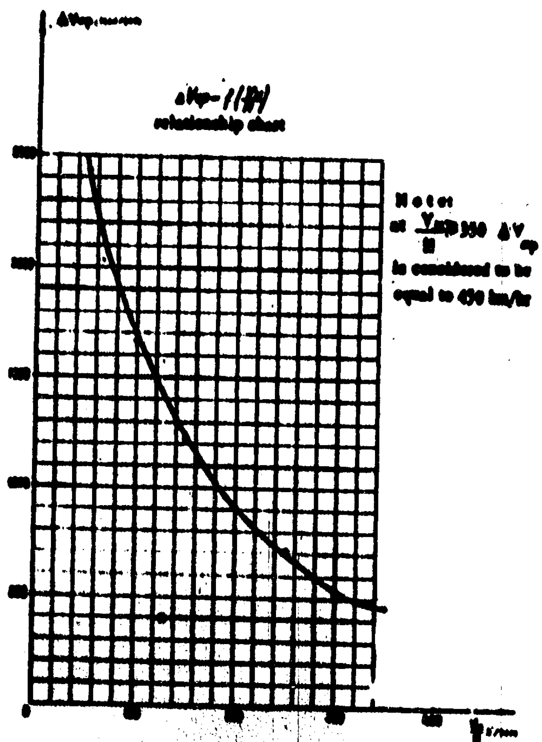

Fig. 2. $\Delta V_{cp} = f\left(\frac{V}{H}\right)$ Relationship Chart

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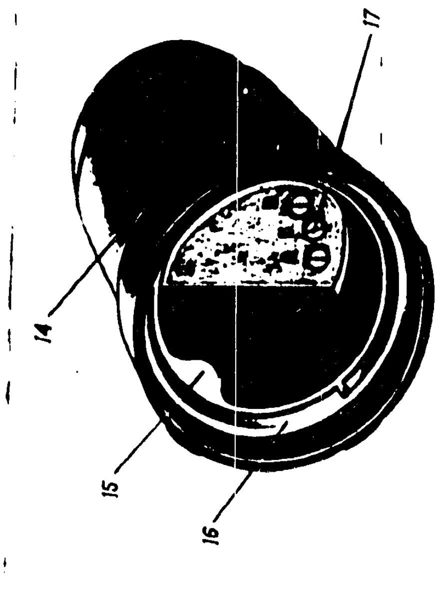

Fig. 6. Altitude Unit

Fig. 7. Follow-Up Unit Outer View

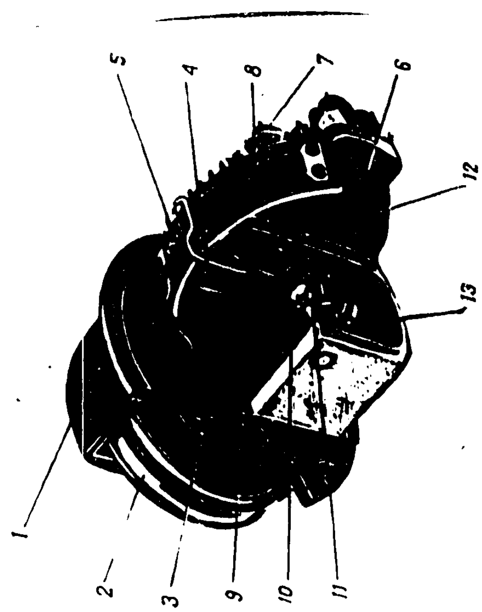

Fig. 5. Altitude Unit (with housing removed)

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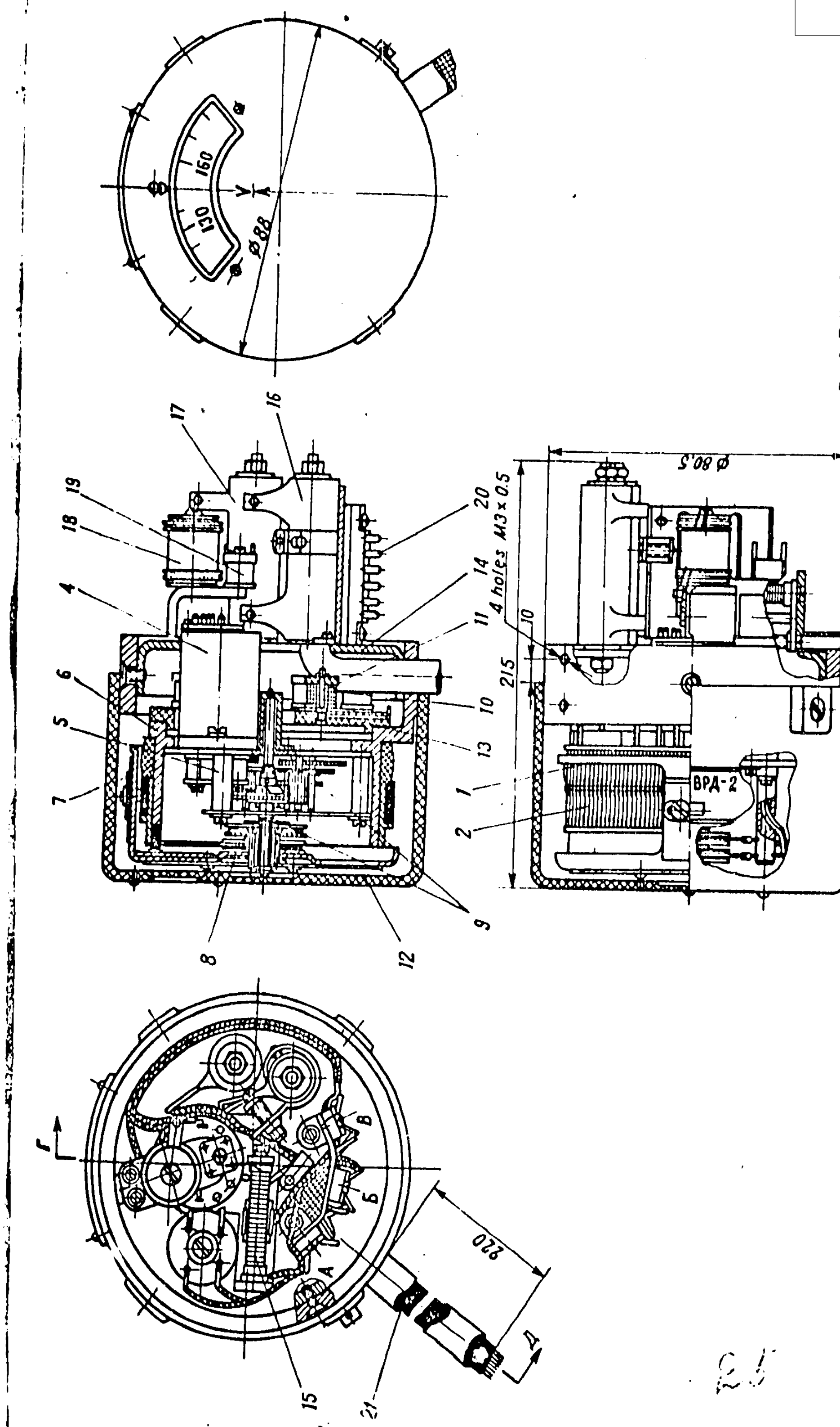

Fig. 8. Follow-Up Unit General View

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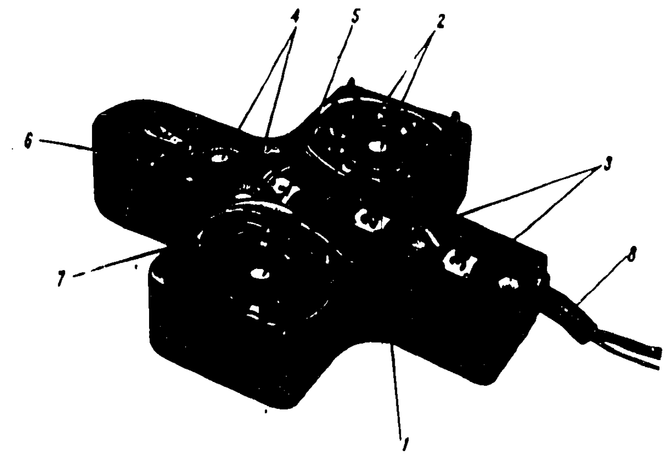

Fig. 10. Magnetic Amplifier Outer View

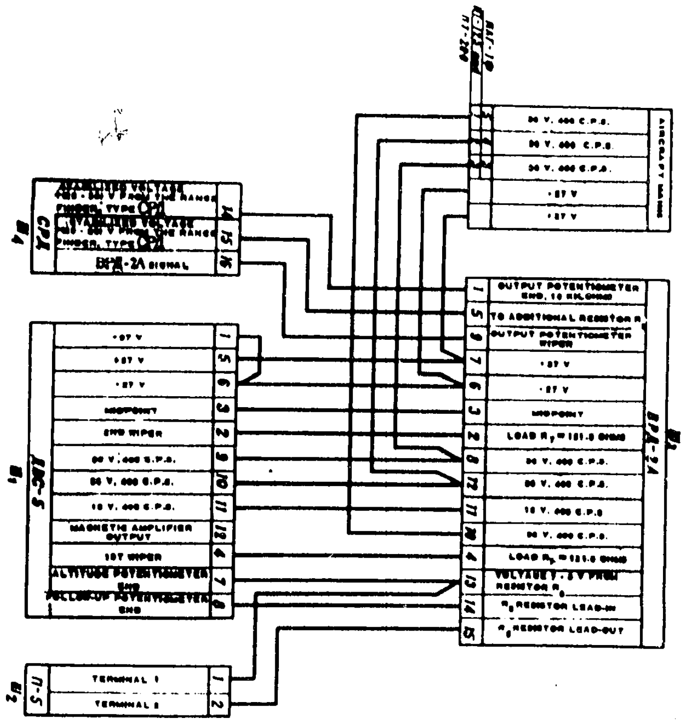

Fig. 11. Cable Connection Diagram of ДВС-5 and ВРД-2А

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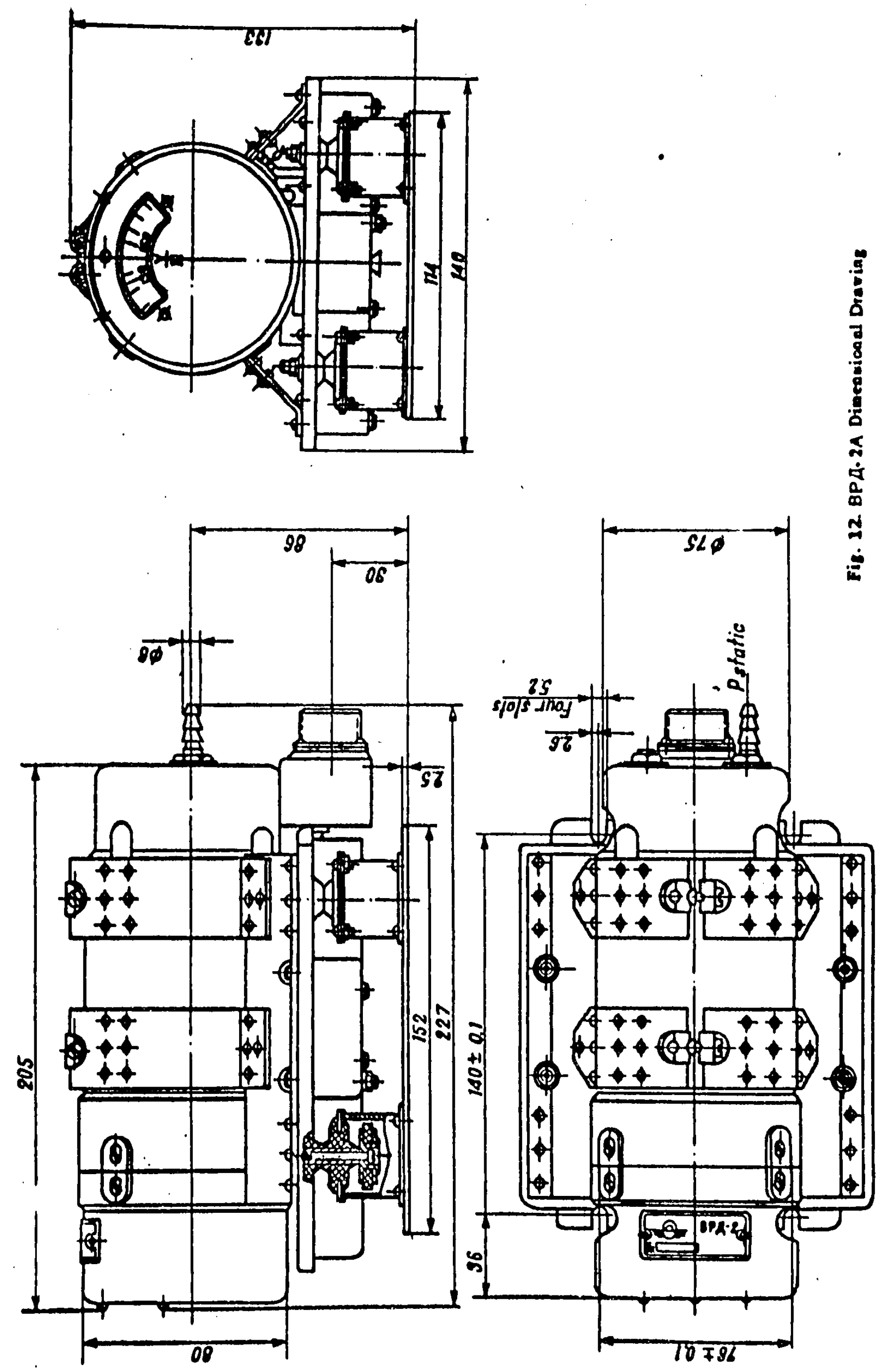

Fig. 12 ВРД-2А Dimensional Drawing

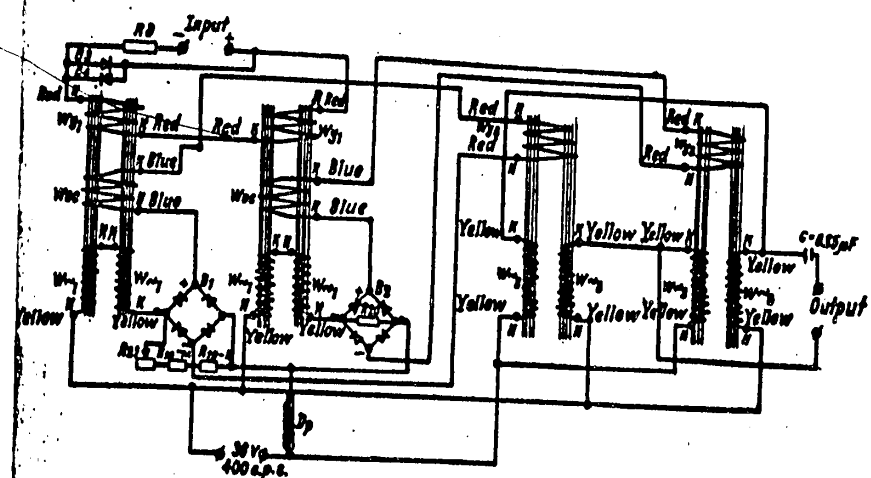

Fig. 13. Key Diagram of Magnetic Amplifier

PNEUMATIC INSTALLATION BLOCK-DIAGRAM

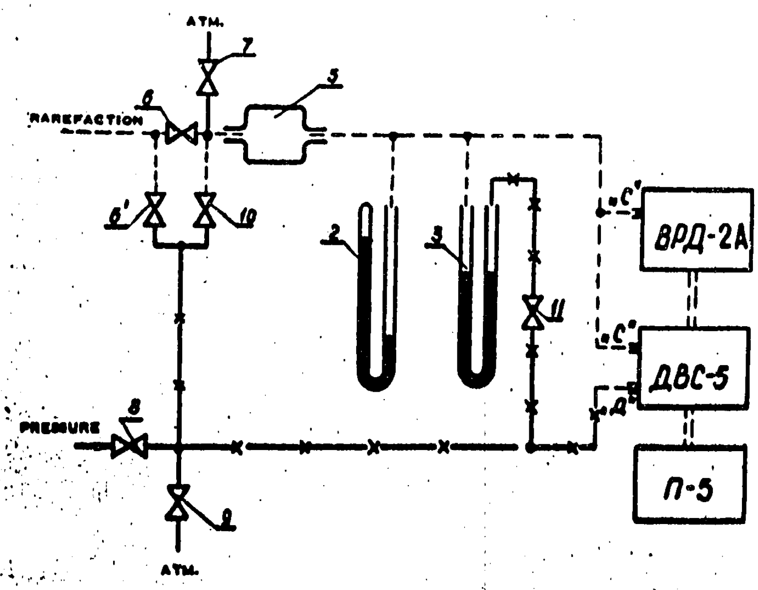

Fig. 14. Pneumatic Installation Block-Diagram

ATTACK AND SLIP ANGLES TRANSMITTER, TYPE ДУАС-8М

Description and Installation Instructions

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C O N T E N T S

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I. PURPOSE

The type ДУАС-8М transmitter (Fig.1) is a remote-reading instrument designed to measure the attack and slip angles of the aircraft, as well as to pick up the total and static pressures.

II. OPERATING PRINCIPLE AND CONSTRUCTION

The type ДУАС-8М transmitter is a pipe (the body of the transmitter) with built-in angle of attack transmitter 5, angle of slip transmitter 2, and Pitot-static tube 1 (Fig.2).

The Pitot-static tube represents a hollow pipe with a smooth outer surface provided with a centrally located opening for receiving the total pressure. At some distance from the end of the pipe there are ten openings 11 to receive static pressure. Moisture coming into the pipe is drained through a special hole located at some distance from the end.

To prevent ice formation, a heating element is incorporated inside the pipe.

The total and static pressures are transmitted via two pipelines 10, 3x4 mm in diameter, running through the body of the transmitter. The transmitter body bears marks C and Д indicating the static-pressure and the dynamic-pressure lines respectively.

To measure the attack and slip angles, the transmitter has four rotatable vanes 2 and 5 mounted in pairs on two axles placed normal to each other inside the body. The front pair of vanes 2 serves to measure the angle of slip, whereas the rear pair 5 - the angle of attack.

The transmitter operates on the principle that any alteration in the position of the vanes, correspondingly changes the output relative resistance (voltage) value. Each position of the vane corresponds to a definite value of the

output relative resistance (voltage) expressed in per cent by the ratio:

$$\frac{R_{output}}{R_{total}}$$

Each vane pair with counterweight 3 is fixed in base 4. Each counterweight carries wiper holder 8 and a wiper secured by two screws. Any change in the angle of attack or in the angle of slip is sensed by the wiper which, being linked with the vane pair, slides across stationary potentiometer 9.

The potentiometer winding is of type ПЭК wire, 0.05 mm in diameter, wound on a ceramic frame. The vane assemblies and the potentiometers are detachable units and should be adjusted separately. The transmitter vanes are completely balanced statically relative to their axes of rotation.

The vane assemblies are fixed inside the split circular body 6 by means of screws.

The power supply is connected in compliance with the circuit diagram of the transmitter, shown in Fig.3.

To obtain better accuracy of the relative resistance data, the circuit makes use of additional shunt resistors.

Each vane mechanism is provided with a heating element to prevent ice formation.

III. BASIC SPECIFICATIONS

1. The operating ambient temperature range of the instrument is from +50 to -60°C.

2. The deflection angles of the vanes from the zero position are as follows:

   (a) angle of attack vane, -5.9° (down) and $+17.7^{\circ}$ (up);

   (b) angle of slip vane, $\pm 5.3^{\circ}$.

   Note: In flight the above maximum deflection angles of the vanes correspond to the angle of slip of $\pm 4.5^{\circ}$, and to the angle of attack ranging from -5° to $+15^{\circ}$.

3. The transmitter potentiometers are supplied with D.C. 22 V in the case of the angle of slip potentiometer, and 30V in the case of the angle of attack potentiometer.

The transmitter and the Pitot-static tube heating elements are supplied with direct current or with alternating current of 27 V, 1000 c.p.s. ± 10 per cent.

4. The relative voltage between the potentiometer slider and the negative terminal of the potentiometer changes linearly depending on the angular deflection of the vanes, as shown in the following Tables:

(a) Angle of slip:

Angle of slip	Vane angular deflection	Rated relative voltage, per cent
$-4^{\circ}30'$	$-5^{\circ}18'$	0
$-2^{\circ}15'$	$-2^{\circ}39'$	25
0°	0°	50
$+2^{\circ}15'$	$+2^{\circ}39'$	75
$+4^{\circ}30'$	$+5^{\circ}18'$	100

(b) Angle of attack:

Angle of attack	Vane angular deflection	Rated relative voltage, per cent
-5°	$-5^{\circ}54'$	0
-3°	$-3^{\circ}32'$	10
0°	0°	25
$+3^{\circ}$	$+3^{\circ}32'$	40
$+6^{\circ}$	$+7^{\circ}05'$	55
$+10^{\circ}$	$+11^{\circ}48'$	75
$+15^{\circ}$	$+17^{\circ}42'$	100

5. The relative voltage errors at 0° marks should not exceed ±1.5 per cent.

With the angle of slip vanes deflecting to the left and those of the angle of attack-upwards, if looking downwards and in the direction of flight respectively, the relative output voltage values increase.

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6. At any other mark except 0°, the accuracy of the relative voltage values should not exceed:

± 2 per cent for the angle of attack;

± 3 per cent for the angle of slip.

7. The transmitter withstands vibration within a frequency ranging from 20 to 200 c.p.s. under a 3.5-g acceleration.

8. The transmitter is vibration-proof within a frequency range from 10 to 200 c.p.s. under a 3.5-g acceleration.

9. Following the application of a 4.5 kg/sq.cm.pressure for a period of 3 minutes, the dynamic-pressure line of the transmitter and the Pitot-static tube should remain air-tight at an excessive pressure of 760 mm Hg (with the intake opening and the drain hole sealed hermetically). The pressure drop not over 5 mm Hg in 3 minutes, at the initial excessive pressure of 760 mm Hg is permissible.

10. The static-pressure line of the transmitter with the Pitot-static tube is air-tight (with the static openings of the Pitot-static tube closed). The pressure drop of 10 mm Hg in the static-pressure line during 3 minutes at the line initial excessive pressure of 370 mm Hg is permissible.

11. The current consumed by the heating elements at rated voltage is ranging from 7 to 10 A.

12. Air consumption through the dynamic chamber of the Pitot-static tube at a pressure of 100 mm Hg does not exceed 15 litres per minute.

13. At the temperatures of +50 and +20°C the friction moment about the axles of the angle of attack and the angle of slip vanes does not exceed 50 gr-cm, and at the temperature of -45 and -60°C does not exceed 60 gr-cm.

14. At the relative humidity ranging from 30 to 80 per cent the insulation resistance of the current-carrying components of the transmitter is at least 20 megohms.

15. The dimensions of the transmitter are shown in Fig.4.

16. The weight of the transmitter is not more than 1500 gr, except mounting fittings.

17. The power supply is connected in accordance with the circuit diagram in Fig. 3.

[redacted]

IV. INSTALLATION AND OPERATING INSTRUCTIONS

1. The transmitter is mounted on a rigid boom ahead of the aircraft well clear of local downwash and rammings which might affect its serviceability.

While installing the transmitter, watch to see that the word UP (ВЕРХ) on its body looks upwards and the Pitot-static tube drainage hole is directed straight down.

2. The transmitter is slide-fitted (3rd accuracy grade) 80 mm deep into the boom socket and fixed with screws.

3. The vanes should be oriented relative to the axes of the aircraft, as prescribed by the requirements set forth in the Instructions on the aircraft.

4. The transmitter installed and fixed by screws, measure its setting angles relative to the axes.

The setting angle data is important to introduce corrections into the transmitter readings.

The angles are measured with the accuracy of $\pm 0.05^{\circ}$ using an angle gauge.

The angle value is determined as a difference between the readings of the angle gauge first placed on a platform parallel to the axis and then, on the generatrix of the cylindrically-shaped body, being the body base too.

5. The transmitter is connected according to the diagram into the aircraft mains by means of terminals.

The terminals are rigidly fixed to the structure of the aircraft. The heating circuit of the Pitot-static tube should be provided with a switch.

6. The Pitot-static tube pipelines are coupled to the supply systems of the instruments of the speed and altitude-measuring group, The coupling over a check for air-tightness should be conducted.

7. In case the aircraft and the transmitter are subject to transportation, the vanes should be locked by locking devices and enclosed into a pretective cover. Non-abservance of this rule may lead to damage of the vanes and to wear of the potentiometer windings and sliders.

8. The preflight check consists of:

(a) checking the Pitot-static tube pressure pipelines for air-tightness;

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(b) checking the heating circuits for operation;

(c) checking the vanes for jamming;

(d) checking, by moving the vanes, the potentiometers for output relative resistance.

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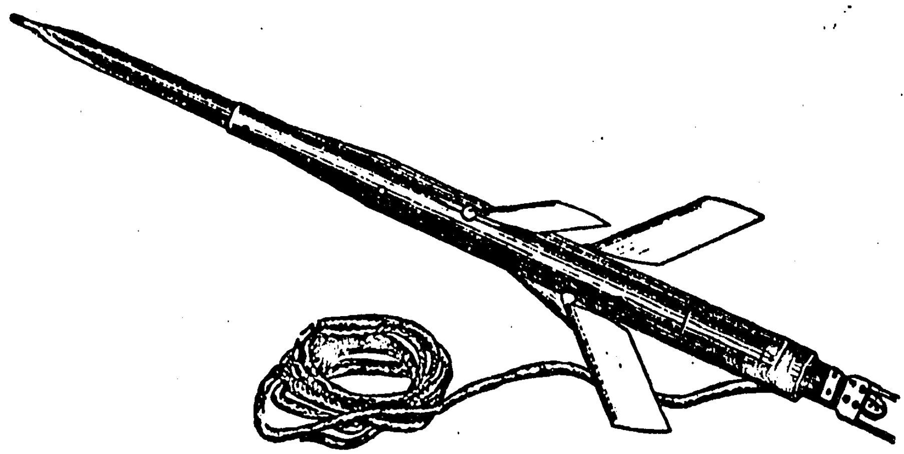

Fig. 1. Transmitter General View

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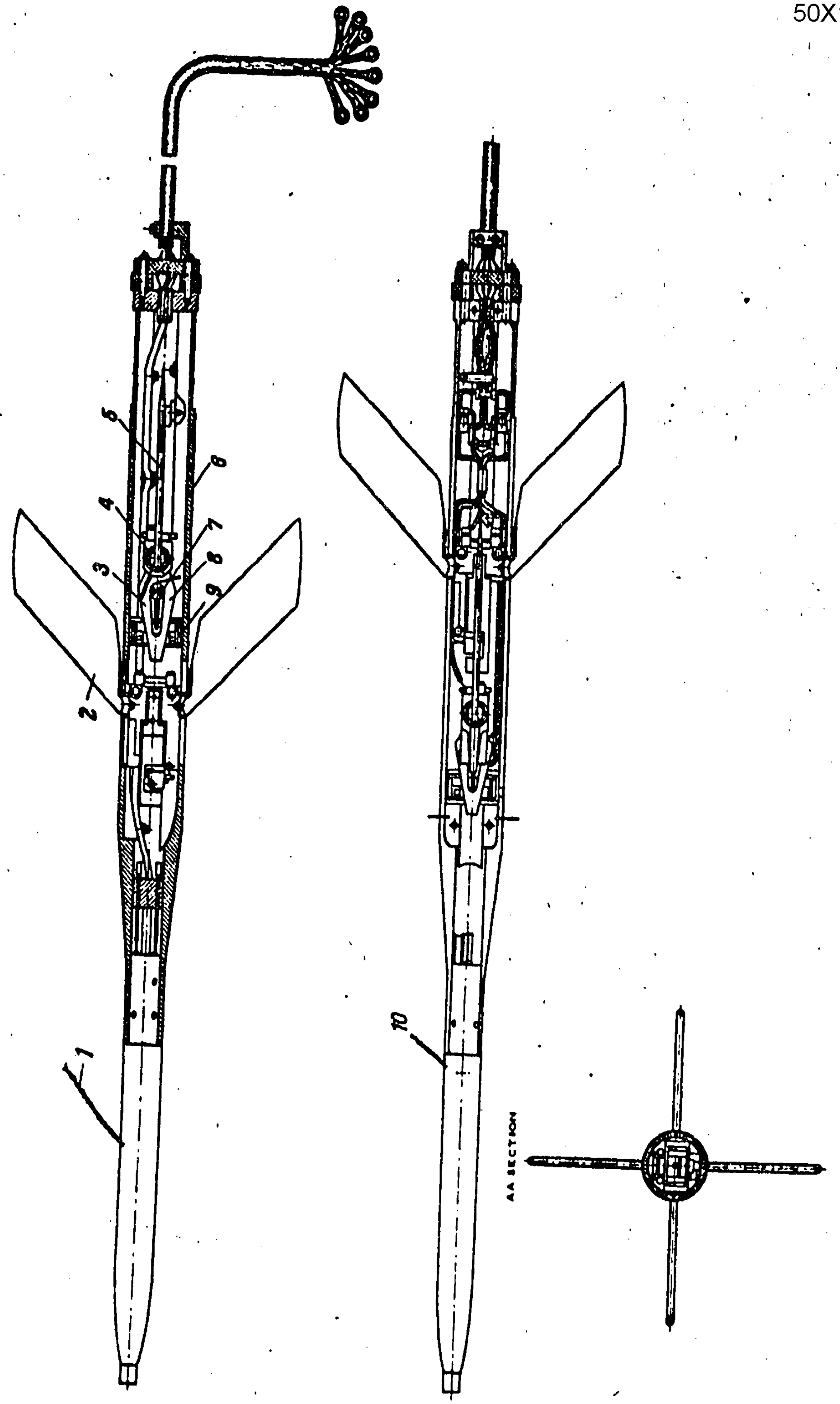

Fig. 2. Cross-Section View of Transmitter

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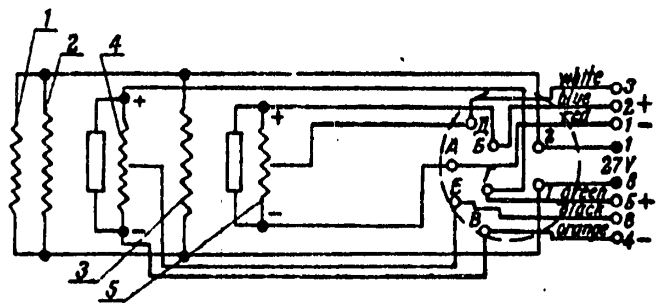

Fig. 3. Electric Circuit Diagram of Transmitter
1 – Pitot-static tube heating; 2 – angle of slip transmitter heating; 3 – angle of attack transmitter heating; 4 – angle of slip potentiometer; 5 – angle of attack potentiometer.

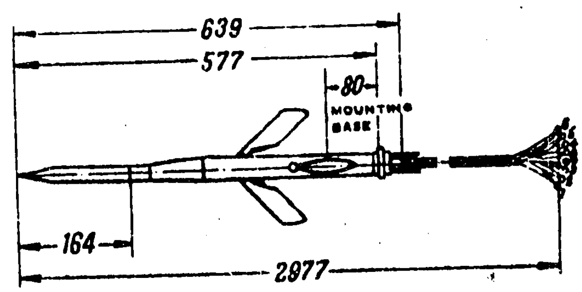

Fig. 4. Overall Dimensions of Transmitter

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AIRCRAFT AUTOMATIC SIGHT
TYPE ASP-5ND
TECHNICAL DESCRIPTION

SECRET

NO FOREIGN DISSEM

GROUP 1
Excluded from automatic downgrading and declassification

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SECRET
NO FOREIGN DISSEM

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AIRCRAFT AUTOMATIC SIGHT TYPE АСП-5НД

TECHNICAL DESCRIPTION

SECRET
NO FOREIGN DISSEM

SECRET

AIRCRAFT AUTOMATIC SIGHT
TYPE АСП-5НД

TECHNICAL DESCRIPTION

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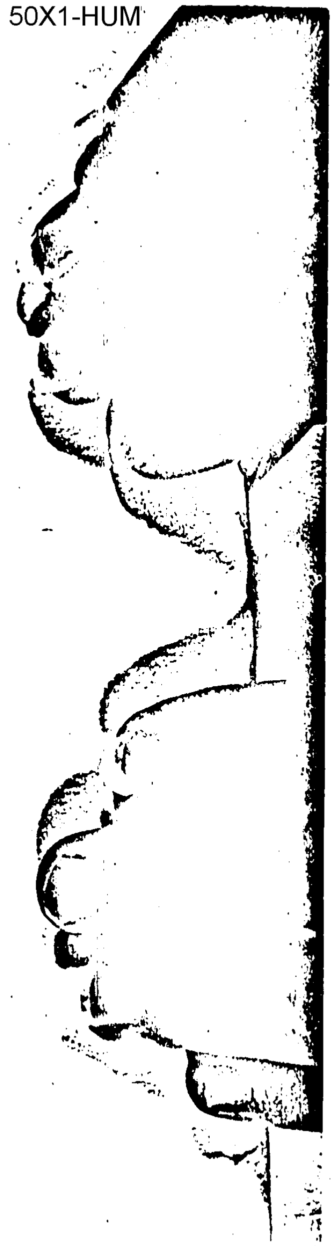

The book contains 292 pages and 12 insets: inset 1 to face page 226; inset 2 to face page 242; inset 3 to face page 250; inset 4 to face page 254; inset 5 to face page 256; inset 6 to face page 260; inset 7 to follow inset 6; inset 8 to face page 266; inset 9 to face page 284; inset 10 to face page 286; inset 11 to follow inset 10; inset 12 to follow inset 11

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Chapter II. MATCHING SIGHT АСП-5НД WITH UNITS PROVIDING FOR FIRE CONTROL PROBLEM SOLUTION

Chapter III. INSPECTION AND CHECKING OF SIGHT

Chapter IV. COMBAT EMPLOYMENT OF SIGHT

Chapter V. EMPLOYMENT OF SPT&A SET AND MAINTENANCE OF SIGHT

Chapter VI. ROUTINE MAINTENANCE

Part I

Sight АСП-5НД is mounted on fighters to ensure accuracy of firing fixed cannon mounts, launching rockets and dropping bombs in a dive.

Sight АСП-5НД is a version of the АСП-5Н sight modified with a view to increasing its accuracy when firing rockets and improving its operation.

Sight АСП-5НД is a complex optical and electro-mechanical unit that should be treated with utmost care.

Before operating the sight one should thoroughly study its construction, operation and maintenance regulations.

Sight АСП-5НД Technical Description consists of two parts. The first part deals with the sight performance, operation and construction. The second part describes sight mounting and arrangement on the aircraft, operating regulations, checking procedure, testing equipment operating instructions and sight employment in combat.

Chapter I

SIGHT SET

The complete set of sight АСП-5НД includes sight units, accessories, spare parts, tools, erecting set and papers.

1. SIGHT UNITS

(a) Sight head	5НД - Assy 1,
(b) Computer	5НД - Assy 42,
(c) Zero gyro with base plate	5НД - Assy 3,
(d) Zero gyro amplifier	5НД - Assy 4,
(e) Control box	5НД - Assy 55[x],
(f) Altitude unit	5НД - Assy 6,
(g) Electron relay with base plate	5НД - Assy 8,
(h) Bracket with light filter	5НД - Assy 11,
(i) Voltage regulator	СН-4

[x] The sight is manufactured with removable ballistic unit C-5M in the control box.

2. ACCOMPANYING PAPERS

(a) Sight Technical Description .... 1 copy
(b) Sight Certificate .... 1 copy

Sight accessories, spare parts, tools and erecting set items are listed in Part II of the Present Description.

Chapter II

PERFORMANCE

1. TACTICAL DATA

1. Sight АСП-5НД is to be employed when firing cannon НР-30, launching rockets and dropping bombs in a dive.

2. The sight continuously and automatically computes the total angular correction of firing and shifts its sighting line in respect to the weapon axis through this total angle.

3. The sight computes the total angular correction within the specified limits at the following conditions of firing:

(a) at air-borne targets:

range to target	200 – 2000 m.
flight altitude	500 – 25,000 m.
ambient temperature	$-60^{\circ}C$ to $+50^{\circ}C$
target speed	500 – 2250 km/hr
own speed	500 – 2500 km/hr

(b) at ground targets:

diving angles	20° – 50°
range to target	200 – 2000 m.
flight altitude	500 – 1500 m.
own speed	600 – 900 km/hr
target speed	0 – 90 km/hr.

4. In case of dive bombing the sight is employed as a simple collimating sight with the sighting line being shifted down in the plane of aircraft symmetry to provide for the lead angle. In this case the lead angle is set stadiametrically (manually) within the range from 30' to 10°.

5. The maximum total angular correction computed by the sight – 13°.

6. The sight computes angular corrections only for one type of weapon. The sight modes of operation are controlled by the selector switches on the sight head bracket.

7. Sight АСП-5НД is employed with the following weapon:

(a) cannon НР-30;

(b) rockets - АРС-57М (С-5М), КАРС-57 (С-5К);

(c) guided missiles УС.

Due to presence of replaceable ballistic units, to use the sight for the precise launching of a new type of rocket, only a new ballistic unit should be manufactured.

8. When launching rockets АРС-57 (С-5М) the sight should operate in conjunction with attack and slip angles transmitter ДУАС.

9. Sight АСП-5НД may operate in conjunction with radio range finders СРД-5МК (КВАНТ) and with any other range finder provided the relationship of the output voltage and circuit connections are preserved.

Range finders ensure an automatic introduction of the target range into the sight.

10. The sight provides also for manual ranging effected by an outer-base optical range finder.

Target dimensions, picked up by the sight, range from 7 to 70 m.

11. The sight has a movable reticle circle of variable diameter with a pip in the centre.

The reticle circle varies its diameter from $1^{o}15'$ to $8'$ only at combinations of bases and ranges indicated in Fig.2.

12. With the gyro in FIXED (НЕПОД.) position, the circle may be formed whose angular value of radius changes from 11 to 70 mils by actuating the BASE - CIRCLE (БАЗА - КОЛЬЦО) handle. In this instance follow the procedure and regulations for firing at air-borne and ground targets prescribed for standard collimating sights.

13. The sight computes angular corrections within the specified limits:

at t = +20°C in 3 min.

at t = -40°C in 10 min.

at t = -60°C in 14 min.

The time necessary for sight heating is included into this value.

14. The target motion synchronises with the reticle pip movement in 3 - 5 sec.

2. OPTICAL DATA

Objective diameter	95 mm
Objective focal length	200 mm
Exit pupil distance	375 mm (as measured from the centre of the reflector)
Pip diameter	$6'$
Width of circle line	$6'$
Brightness of circle image	at least 30 stilbs
Brightness of central pip	at least 36 stilbs.

3. ELECTRICAL DATA

1. The sight precisely computes angular corrections when fed with D.C. of 27 V$\mp$10%, single-phase A.C. of 115 V$\mp$5%, 400 c.p.s. At a voltage of 115 V$\mp$10% the sight is still serviceable.

2. The power, consumed by the sight, comprises:

D.C. current	
at normal conditions	300 W
at $t = -40^{0}$C and below	400 W
A.C. current	120 V/A

3. The sight computing systems employ gyroscopic units, type АСП, and potentiometric bridge-type circuits, consuming D.C. and employing electron relays as sensing elements and the reversing electromagnetic couplings as follow-up elements.

4. The sight computing circuits are fed with a regulated voltage of 22 $\pm$0.3 V D.C.

4. OPERATING DATA

1. The sight operation mode is set by the selectors arranged on the sight head bracket.

When changing over the mode of operation the selectors may be set to the following positions:

С - РС - ДУАС - for rocket launching when operating the sight via ДУАС transmitter;

С – РС – Н – for rocket launching when operating the sight via altitude unit;

С – НР-30 – for cannon firing;

Б – for dive bombing.

2. Sight changing over for operation with the range finder of this or that type is performed on the ground by actuating special selectors in the control box and computer.

3. The sight is cut in to automatic ranging by setting the RADAR – OPTICS (РАДИО – ОПТ.) switch on the sight head bracket to the RADAR (РАДИО) position. The sight may be changed over to manual ranging either automatically, when the range finder signal TARGET LOCK UP disappears, or manually by setting the RADAR – OPTICS switch to the OPTICS position.

4. Setting, type PC, is performed on the ground by placing an appropriate ballistic unit into the sight control box.

5. Range, altitude and indicated time are visually followed on the ground by proper scales of the computer and the altitude unit through connecting the radar ranging unit simulator and special vacuum set to the sight.

6. In flight the target range may be visually checked by the range indicator mounted on the sight head bracket.

7. When the radar ranging unit locks up a target, green warning lamp LOCK-UP (ЗАХВАТ), mounted on the sight head, goes on.

8. Break off is checked by red warning lamp BREAK OFF (ВЫХОД) arranged on the sight head. The lamp goes on at a target range of 600^{+80}_{-40} m. and keeps on burning at less range.

9. The sight field of vision is checked by the camera gun, type СШ-45.

10. The testing equipment (КП5СД) is to be attached to reference connectors provided in the control box and the zero gyro amplifier.

The manufacturing plant produces sights АСП-5НД equipped with infra-red sighting device СИВ-52 intended to deliver aimed fire at night. The sighting device construction and operation are outlined in separate descriptions.

Special optical attachment (OЭC) projects the sight reticle pip to the objective of the infra-red sighting device.

Fig.3 shows mutual arrangement of the sight head, infra-red sighting device, and optical attachment unit.

Due to mounting of the infra-red sighting device, the sight head and its bracket have undergone the following changes:

1. The sight head body has a slot to secure the optical attachment unit.

2. The shape of the sight reflector provides for a suitable arrangement of the sighting device in respect to the pilot's eye.

3. The light-filter bending radius is increased to clear the optical attachment unit when the light filter is set to the inoperative position.

The sighting procedures do not change when the sight operates in conjunction with the infra-red sighting device.

5. WEIGHT

1. Sight units weight:

(a) sight head	9.1 kg
(b) computer	6.0 kg
(c) zero gyro with base plate	5.1 kg
(d) zero gyro amplifier	4.2 kg
(e) control box	9.5 kg
(f) altitude unit	2.2 kg
(g) electron relay	3.2 kg
(h) voltage regulator	4.5 kg
(i) bracket with light filter	3.7 kg
(j) range manual introduction potentiometer	0.04 kg
2. Maximum sight set weight	30.0 kg
3. Maximum weight of sight set in packing box	125.0 kg

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6. DIMENSIONS

Sight units overall dimensions:

(a) sight head	....	262x363x278 mm
(b) computer	....	220x157x246 mm
(c) zero gyro with base plate	....	235x132x153 mm
(d) zero gyro amplifier	....	218x130x160 mm
(e) control box	....	262x162x136 mm
(f) altitude unit	....	192x115x115 mm
(g) electron relay	....	235x103x154 mm
(h) voltage regulator	....	270x160x150 mm
(i) bracket with light filter	....	234x278x269 mm

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Chapter III

FIRE CONTROL PROBLEM AND DEDUCTION OF OPERATING FORMULAS

1. GENERAL FIRE CONTROL PROBLEM

When firing shells and rockets the sight should ensure the position of the weapon necessary for engaging the target.

To hit the target one should exactly know how the projectile travels after departing the gun (law of projectile motion) and the distance that the target covers during the period of projectile flight (law of target motion). The law of projectile motion makes it possible to direct the gun in such a way as to hit the given point of space. The law of target motion enables the gunner to make allowance for the target travel during the period of projectile flight. To hit the target it is necessary to compute on the target trajectory the point which will be simultaneously reached by the target and the projectile. Considering at the moment of fire the collision point as a given point it is possible to set the weapon so that the projectile travels through this point.

Hence, the problem of aiming at a moving target is conventionally divided into two parts:

(1) determination of projectile-with-target collision point;

(2) aiming at a given point of collision.

The fighter weapon is rigidly secured to the airframe and its axis may be set in parallel to the aircraft fore-and aft axis or as some constant angle to it in the aircraft plane of symmetry.

Therefore, the target will be engaged provided that an angle is formed by the fighter fore-and-aft axis and the movable sighting line. Sight АСП-5НД solves the fire control problem by automatically and continuously computing this angle for different firing conditions and deflecting the sighting line through this angle.

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The solution of the fire control problem boils down to the calculation of target travel and the projectile drop due to gravity as it covers the predicted range. The influence of the aircraft slip angle on the projectile path should be also taken into account.

As it is known from mechanics, the movement of any body may be determined only in relation to another given body. When solving the fire control problem for a fighter, the air is considered to be a reference body. Hence, hereafter in this description the target and projectile movement will be considered in reference to air.

Movement of the target as the projectile covers the predicted range is compensated for by deflecting the cannon in the same direction through a certain angle relative to the sighting line at the moment of firing. This angle is termed angle of lead.

For the time of projectile flight the moving target will travel from point A_o, where it was at the moment of firing, to another point A_y (Fig.4). To engage the moving target the cannon should be directed forward in line with target movement so as to allow the target and the projectile to collide.

In other words, it is necessary to make allowance for the target speed. Point A_y, where the target and the projectile should collide, is called the predicted point or point of collision.

To determine the point of collision the law of target motion should be regarded. When firing, the law of target motion is taken into account by assuming this or that hypothesis of the target movement. In case with sight АСП-5НД the target travel during the time of projectile flight is assumed to be straight and uniform ($\bar{V}_ц$ = const).

This assumption is quite natural in case with a fighter shooting at a bomber as the heavy-weight bomber can not sharply change its speed during the time of projectile flight. Accordingly, point of collision A_y is situated on the extension of vector $\bar{V}_ц$ at distance L from initial point A_o. Triangle OA_oA_y is termed a prediction triangle and its components:

L – linear prediction,
$Д_о$ – initial range,
$Д_у$ – predicted range.

When the target moves straightly and uniformly, the linear prediction equals:

$$L = V_ц \cdot t_y$$

where t_y – time of projectile flight to the predicted point.

The prediction triangle is formed by lead angle ϕ and target course angle q.

Angle ϕ may be determined by applying the sine theorem to the prediction triangle:

$$\frac{\sin \phi}{\sin q} = \frac{V_ц \cdot t_y}{Д_у}$$

The relation of the predicted range to the time of projectile flight is projectile mean velocity V_{op}

$$\frac{Д_у}{t_y} = V_{op}$$

At present conditions of firing the lead angle does not exceed 15°. Therefore, it is possible to assume that $\sin \phi \simeq \phi$. Then the formula of the lead angle becomes:

$$\phi = \frac{V_ц \cdot \sin q}{V_{op}} \qquad (1)$$

This formula can not be used to compute the lead angle in the automatic sight, type АСП-5НД. Hence, the lead angle is expressed by the values which may be directly measured while aiming.

One of such values is angular velocity of the line of sight ($\omega_ц$). The angular velocity of the line of sight is the rotative speed of the line connecting the firing aircraft with the target (Fig.5).

This value may be directly and precisely measured at sighting.

Find the expression for the angular velocity of the line of sight supposing that the sight computes only the lead angle and that the sighting is properly carried out. As is

known from mechanics, the angular velocity of rotation of line 1 in space equals the difference between the lateral velocities of the section ends divided by the section length (Fig.6). Lateral velocities V_{n_2} and V_{n_1} are the components of the section ends velocities perpendicular to the section length. Use this rule to compute the angular velocity of the line of sight.

From the prediction triangle (Fig.7):

$$V_{n_2} = V_Ц \cdot \sin q$$

$$V_{n_1} = V_1 \cdot \sin\phi \approx V_1 \cdot \phi$$

therefore,
$$\omega_Ц = \frac{V_Ц \cdot \sin q - V_1 \cdot \phi}{Д_0}.$$

This formula indicates that value $V_Ц \cdot \sin q$ may be expressed by the angular velocity of the line of sight:

$$V_Ц \cdot \sin q = \omega_Ц \cdot Д_0 + V_1 \cdot \phi$$

Using formula (1) arrive at:

$$\phi = \frac{V_Ц \cdot \sin q}{V_{op}} = \frac{\omega_Ц \cdot Д_0 + V_1 \cdot \phi}{V_{cp}}$$

wherefrom

$$\phi = \omega_Ц \cdot \frac{Д_0}{V_{cp} - V_1} \qquad (2)$$

The multiplier of $\omega_Ц$, expressed in time units, is termed computed time and designated by T_p.

Formula
$$\phi = \omega_Ц \cdot T_p \qquad (3)$$

is used to compute the lead angle in sight АСП-5НД.

At given ballistics, the computed time is determined by range Д and altitude H. Therefore, at given ballistics, the lead angle depends on three values:

$$\omega_Ц; \quad Д; \quad H.$$

The gravity drop of the projectile as it covers the predicted range is compensated for by constructing the elevation angle in the vertical plane.

The amount of the elevation angle depends on firing conditions, weapon ballistic characteristics and is determined by the relationship:

$$\alpha_{\text{пр}} = \frac{S}{Д_{у}} \qquad (4)$$

Projectile drop S is a ballistic function of the range, altitude and projectile muzzle velocity. However, when constructing angle $\alpha_{\text{пр}}$ it is necessary to make allowance for the deflection of the line of sight from the aircraft fore-and-aft axis. Thus, target tracking by the deflected line of sight is effected through turning the aircraft not in the lead angle plane, but in the plane deflected through the elevation angle. This causes a change of the computed angular velocity of the line of sight, and hence, a change of the computed value of the lead angle calculated by the sight. To get the required angle of lead, the corrected value of the elevation angle is to be fed into the sight.

$$\alpha^{x} = \alpha_{\text{пр}} \frac{V_{op}}{V_{op} - V_1} \qquad (5)$$

The elevation angle should be constructed in the vertical plane. In sight АСП-5НД the space position of the vertical plane is not determined, so the elevation angle is constructed by using two components:

$\alpha^{x}_{в}$ – vertical component (in the aircraft plane of symmetry);

$\alpha^{x}_{г}$ – horizontal component (in the plane perpendicular to the aircraft plane of symmetry).

Hereafter, all the angular corrections in the aircraft plane of symmetry will be conventionally termed vertical corrections, and all the angular corrections in the wing plane – horizontal corrections.

Divide the elevation angle into two components:

$$\alpha^{x} = \alpha_{\text{пр}} \cdot \frac{V_{op}}{V_{op} - V_1} = \frac{S}{Д_{у}} \cdot \frac{V_{op}}{V_{op} - V_1} = \frac{S_1}{Д_{у}} \qquad (6)$$

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Projectile gravity drop S_1 (Fig.8) lies in the vertical plane. The projection of the projectile drop on the plane, perpendicular to the aircraft axis, equals:

$$AC = S_1 \cdot \cos\lambda$$

Divide section AC in the plane perpendicular to the axis of the banked aircraft into two components running along axes X and Y:

$$AД = AC \cdot \cos\theta \qquad AE = AC \cdot \sin\theta$$

Hence, when dividing the elevation angle into two components, the latter are expressed as follows:

$$\alpha_B^x = \frac{AД}{Д_y} = \frac{S_1}{Д_y} \cdot \cos\theta \cdot \cos\lambda$$

$$\alpha_\Gamma^x = -\frac{AE}{Д_y} = -\frac{S_1}{Д_y} \cdot \sin\theta \cdot \cos\lambda$$

where θ – angle of bank;

λ – angle of diving.

Thus, the components of the elevation angle equal:

$$\alpha_B^x = \alpha^x \cdot \cos\theta \cdot \cos\lambda \qquad (7)$$

$$\alpha_\Gamma^x = -\alpha^x \cdot \sin\theta \cdot \cos\lambda \qquad (8)$$

The aircraft angle of attack and slip angle affect the projectile velocity at the point of departure. Due to the angle of attack the projectile trajectory deflects down in the fighter plane of symmetry whereas due to the slip angle it deflects in the wing plane in the direction of slipping.

Mark the angle, through which the projectile trajectory deflects at the moment of departure due to the angle of attack α as β_a (Fig.9).

Applying the sine theorem and considering that angles α and β_a are rather small, we have:

$$\frac{\beta_a}{V_1} = \frac{\alpha}{V_{01}}$$

wherefrom

$$\beta_\alpha = \frac{V_1}{V_{01}} \cdot \alpha \qquad (9)$$

Mark the angle, through which the projectile trajectory deflects due to the aircraft slip angle β, as β_o. Then

$$\beta_o = \frac{V_1}{V_{01}} \cdot \beta \tag{10}$$

To make allowance for the attack and slip angles the sight should compute the angular corrections with the aid of expressions (9) and (10).

$\bar{V}_o$ – projectile muzzle velocity vector,

$\bar{V}_1$ – fighter velocity vector,

$\bar{V}_{01}$ – projectile total muzzle velocity vector,

α – fighter angle of attack,

β_a – correction for the fighter angle of attack.

Thus, to solve the fire control problem the weapon axis should be deflected with respect to the line of sight through some angle termed a total angular correction.

The total angular correction includes corrections for target motion, projectile drop, and fighter slipping (Fig.10). Sight АСП-5НД computes corrections in two planes: in the aircraft plane of symmetry and in the wing plane.

The total angular correction equals:

$$\phi_{\varepsilon} = \phi + \alpha_{\text{пр}} + \beta'$$

where β' – angular correction for fighter slipping.

2. DEDUCTION OF OPERATING FORMULAS COMPUTED BY SIGHT

A. Correction for Target Motion (angle of lead)

The previously obtained theoretical relationship for the computation of lead angle $\phi = \omega_{\text{ц}} \cdot T_p = \omega_{\text{ц}} \cdot \dfrac{Д_0}{V_{op} - V_1}$ is difficult to be solved.

In sight АСП-5НД the lead angle is computed by means of a free gyro. The aiming is effected by a movable sighting line through turning the weapon (aircraft) axis. The pilot chooses the aircraft angular velocity so as to have the sighting line directed at the target. With a synchronous tracking of the target, the sighting line travels at an angular velocity of $\omega_{\text{в.л}} = \omega_{\text{ц}}$

When tracking the target, the angular velocities of the fighter and of the line of sight are connected by the relationship $\omega_{o} = \omega_{в.ц} + \phi$. In case of a synchronous tracking of the target, the relationship becomes

$$\omega_{o} = \omega_{ц} + \phi \qquad (11)$$

This relationship is easy to be understood from Fig.11. $\alpha_{o} = \alpha_{ц} + \phi$, where

α_{o} and $\alpha_{ц}$ – angles determining the position of the aircraft axis and of the line of sight in relation to the selected reference line.

ϕ – lead angle.

In case with the angular velocities, we have:

$$\alpha_{o} = \alpha_{ц} + \phi \quad \text{or} \quad \omega_{o} = \omega_{ц} + \phi\text{, where}$$

ϕ – rate of lead angle change.

When the fighter is turning, the gyro processes in the direction of the aircraft movement with speed $\omega_{пр}$ and its axis always lags from the aircraft axis through angle φ (Fig.12).

The rate of precession equals:

$$\omega_{пр} = \omega_{o} - \varphi\text{ , where}$$

φ – rate of mismatching angle change.

Making allowance for equation (11), we arrive at:

$$\omega_{пр} = \omega_{ц} + \phi - \varphi \qquad (12)$$

The gyro theory states that

$$\varphi = \frac{1}{A} \cdot \omega_{пр} \qquad (13)$$

i.e. the mismatching angle is in direct proportion to the angular rate of the gyro precession.

Substituting $\omega_{пр}$, we have:

$$\varphi = \frac{1}{A} \cdot (\omega_{ц} + \phi - \varphi) \qquad (14)$$

To ensure the adequate controllability of the line of sight, semi-automatic optical sights are provided with optical transmission ratio depending on mutual arrangement of the optical elements (gyro mirror, reticle, objective).

The optical system transmission factor is designated by μ and equals

$$\mu = \frac{\varphi}{\phi}\text{, where:}$$

φ – angle of lag of the gyro axis from the aircraft axis;

ϕ – lead angle.

Introduction of factor μ into formula (14) gives:

$$\phi = \frac{1}{\mu A}\left(\omega_{\text{Ц}} + \phi - \mu\phi\right)$$

$$\text{or } \phi = \frac{1}{\mu A}\left[\omega_{\text{Ц}} - (\mu - 1)\phi\right]$$

Assuming $\frac{1}{\mu A} = T$, and $(\mu - 1) = K$, we get the lead angle formula:

$$\phi = (\omega_{\text{Ц}} - K\phi)\,T \qquad (15)$$

Member $K\phi\cdot T$ introduces an error into the lead angle computation. However, the analysis has proved that the absence of this member ($K = 0$), though resulting in precise computation of the lead angle, would complicate continuous synchronization of the line of sight and target movement, as the sight reticle (and, hence, the line of sight) would become too movable.

With $K > 0$ the line of sight is a sort of damped, i.e. the sight reticle becomes less movable and is easier to be controlled. Therefore, coefficient K, termed a damping ratio should exceed zero.

It is evident that the maximum angle of lead, that may be computed by the sight constructed by this principle, depends on the gyro axis maximum deflection angle φ_{max} and transmission factor μ.

However, the both values are restricted due to the following considerations.

The increase of the gyro maximum deflection angle gives a rise to technical difficulties connected with the gyro increased dimensions, and adversely affects the precision of the gyro operation. The decrease of factor μ brings about reduction of the damping ratio and worsens laying conditions. Therefore, it is desirable that the transmission ratio μ does not go down below the rated value.

The adequate controllability of the line of sight may be also obtained by changing gyro flexibility through creating an additional moment proportional to the angular velocity of the aircraft axis.

When the gyro is acted upon by the additional moment, the additional shifting of the gyro axis occurs. Due to the high transmission factor of the optical system, the line of sight is similarly shifted.

The АСП-5НД sight, whose gyro is acted upon by the main and additional moments, computes angle ϕ as follows:

$$\phi = \phi_{осн} - \phi_{доп}$$

$\phi_{доп}$ - angle formed due to acting on the gyro by the gyro unit correction coils moment proportional to the aircraft axis angular velocity.

$$\phi_{доп} = P \cdot \omega_o \cdot T' \qquad (16)$$

where

ω_o - aircraft angular velocity;
T' - changed indicated time;
P - proportionality factor.

When substituting T' for T, the angle of deflection of the sighting line from the sight axis, provided that the correction coils moment does not act upon the gyro, equals:

$$\phi_{осн} = (\omega_ц - K \cdot \phi) T' \qquad (17)$$

Using equations (11) and (16), we have:

$$\phi = (\omega_ц - K\phi \ ) T' - P \cdot \omega_o \cdot T' =$$
$$= (\omega_ц \ - K\phi \ ) T' - P (\omega_ц + \phi \ ) T' =$$
$$= [\omega_ц - \frac{K + P}{1 - P} \cdot \phi] \ T' (1 - P)$$

To have the total angle ϕ equal to the computed angle of lead, the following equations should be observed:

$$T' (1-P) = T \text{ and } \frac{K + P}{1 - P} = K^x$$

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where: K^x – required damping ratio ensuring the best target tracking conditions. In sight АСП-5НД the damping ratio equals 0.2. It is ensured by the optical system transmission factor μ (partially) and by the correction moment, created by the zero gyro. $\mu = 1.066$; $P = 0.11167$.

Thus, sight АСП-5НД solves the following formula of the lead angle:

$$\phi = (\omega_{Ц} - K^x \cdot \phi)\, T$$

The main component of the angle of lead ϕ'_{OCH} is wholly constructed in the plane of target tracking. From now on, for the sake of convenience, we shall proceed with the assumption that the lead angle is constructed by two components:

$$\phi_B = (\omega_{ЦB} - K \cdot \phi_B)\, T' - P \cdot \omega_{CB} \cdot T'$$

$$\phi_Г = (\omega_{ЦГ} - K \cdot \phi_Г)\, T' - P \cdot \omega_{CГ} \cdot T'$$

B. Correction for Projectile Drop (elevation angle)

To make an allowance for the projectile drop, the sight should compute the following angular corrections:

$$\alpha_B^x = \alpha^x \cdot \cos\theta \cdot \cos\lambda$$

$$\alpha_Г^x = -\alpha^x \cdot \sin\theta \cdot \cos\lambda$$

The construction of angles α_B^x and $\alpha_Г^x$ by these formulas would result in complicated construction of the sight, which should be furnished with the transmitters of the dive and bank angles, geometrical plotters and other devices. Therefore, the formulas are changed so as to compute the angles without considerable complication of the sight.

The formula for $\alpha_Г^x$ is rearranged in the following way.

Assume that at dive angle λ and bank θ the fighter makes a turn with angular velocity ω_0 (Fig.13).

In case of a correct turn (without slipping) lifting force P counterbalances the component of the aircraft weight $G \cdot \cos\lambda$ and centrifugal force $F_Ц = m \cdot \omega_0 \cdot V_1$.

From Fig.13 we have:

$$tg\,\theta = \frac{F_{\text{ц}}}{G \cdot \cos\lambda} = \frac{m \cdot V_1 \cdot \omega_0}{mq \cdot \cos\lambda} = \frac{V_1 \cdot \omega_0}{q \cdot \cos\lambda},$$

where q – gravitational acceleration.

Then the product of $\sin\theta \cdot \cos\lambda$ may be presented as:

$$\sin\theta \cdot \cos\lambda = tg\,\theta \cdot \cos\lambda \cdot \cos\theta = \frac{V_1 \cdot \omega_0 \cdot \cos\theta}{q},$$

where $\omega_0 \cdot \cos\theta$ – horizontal component of angular velocity ω_0.

Hence:

$$\alpha_{\Gamma}^{x} = -\alpha^{x} \cdot \frac{V_1 \cdot \omega_{cr}}{q}.$$

The multiplier of ω_{cr} is a function of the same values as computed time T_p. The computations prove that for any projectile trajectory this multiplier may be written as $P' \cdot T'$.

Then the expression for α_{Γ}^{x} will become:

$$\alpha_{\Gamma}^{x} = -P' \cdot \omega_{cr} \cdot T'$$

The horizontal component of the elevation angle is constructed and directed in the same manner as the additional angle of the horizontal component of the lead angle. Therefore, the construction of α_{Γ}^{x} may be matched with the construction of the additional angle horizontal component when computing the lead angle. The sight computes this total angle through the increase of the additional angle when computing the lead angle in the horizontal plane. The expression for the horizontal component of the lead angle will become:

$$\phi_{\Gamma} = (\omega_{\text{Ш}\Gamma} - K\,\phi_{\Gamma}) \cdot T' - P \cdot \omega_{cr} \cdot T' - P' \cdot \omega_{cr} \cdot T',$$

where P' – constant coefficient.

As the computations proved the average value of the product of $\cos\lambda \cdot \cos\theta$ in the expression for the vertical component of the elevation angle may be assumed to be $E = 0.6$ and miltiplier α^{x} may be presented as $aT + B$.

Then the expression for the vertical component of the elevation angle becomes:

$$\alpha_B^x = E\,(aT + B) = Ea \cdot T + E_B$$

Composing constant coefficients, we arrive at:

$$\alpha_B^x = a'T + B'$$

The angle equal to $a'T$ is constructed by the sight together with the vertical component of the additional angle of lead.

The expression for the lead angle vertical component becomes:

$$\phi_B = (\omega_{HB} - K\,\phi_B)\,T' - P \cdot \omega_{OB} + a'T$$

Constant member B' is computed in conjunction with the vertical correction for the aircraft slipping.

C. Correction for Aircraft Slipping

As it was already discussed, the correction for the aircraft slipping is composed of two components β_a and β_o, which depend on the fighter angles of attack and slip in the wing plane.

$$\beta_a = \frac{V_1}{V_{01}} \cdot \alpha \qquad \beta_o = \frac{V_1}{V_{01}} \cdot \beta ,$$

where:

α – fighter angle of attack;

β – fighter angle of slip (in the wing plane).

Fig.9 shows that value β_a (or β_o) depends on the correlation of fighter speed V_1 and projectile muzzle velocity V_o. At the moment of firing the muzzle velocity of the rifled cannon projectile considerably exceeds the fighter speed. Therefore, the value of these angles is so small that they may be practically disregarded and the projectile direction of path may be considered to be aligned with the direction of the aircraft (weapon) axis.

The rocket launching speed is considerably less than the fighter speed, therefore, at a certain slip angle the rocket path will deflect from the aircraft fore-and-aft axis through a considerable angle which cannot be disregarded.

To compute the theoretically required total angle, the correction for the aircraft slipping should be introduced into the sight by following expressions:

$$\beta_a = \frac{V_{op}}{V_{op} - V_1} \cdot \left(\frac{V_1}{V_{01}} - \frac{V_1}{V_{op}} \right) \cdot \alpha$$

$$\beta_o = \frac{V_{op}}{V_{op} - V_1} \cdot \left(\frac{V_1}{V_{01}} - \frac{V_1}{V_{op}} \right) \cdot \beta$$

As the computations prove, value $\frac{V_{op}}{V_{op} - V_1} \cdot \left(\frac{V_1}{V_{01}} - \frac{V_1}{V_{op}} \right)$

changes very slightly and for each ballistics of the rocket it may be presented by average value A. Then the operating formulas for the corrections for the fighter attack and slip angles become:

$$\beta_a = A \cdot \alpha$$

$$\beta_c = A \cdot \beta$$

D. Indicated Time Formula Computed by Sight

The indicated time of each type of the projectile is a ballistic function of range, altitude, fighter speed, target speed and other parameters. Especially important are range and altitude which considerably affect time T. The influence of other parameters is not significant. Therefore, to simplify the construction, sight АСП-5НД computes time T only as a function of the target range and flight altitude; the other parameters are presented by their average values.

The formula for time T reads:

$$T = A + \varphi(Д_0) \cdot f(H),$$

where $\varphi(Д_0)$ – function of initial range;
$f(H)$ – function of altitude;
A – coefficient.

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Coefficient A as well as functions $\varphi(\text{Д}_0)$ and $f(H)$ are different for each type of projectiles.

B. Operating Formulas Computed by Sight

As it was mentioned above, the angular corrections are composed of the vertical and horizontal components.

1. The operating formulas of the lead angle components are:

$$\boxed{\phi_{\text{В}} = (\omega_{\text{ЦВ}} - K\,\phi_{\text{В}} \cdot T' - P\cdot\omega_{\text{СВ}} \cdot T'} \qquad (18)$$

$$\boxed{\phi_{\text{Г}} = (\omega_{\text{ЦГ}} - K\,\phi_{\text{Г}} \cdot T' - P\cdot\omega_{\text{СГ}} \cdot T'} \qquad (19)$$

2. The elevation angle operating formulas are:

$$\boxed{\alpha^{X}_{\text{В}} = a'T + B'} \qquad (20)$$

$$\boxed{\alpha^{X}_{\text{Г}} = -P\cdot\omega_{\text{СГ}} \cdot T'} \qquad (21)$$

3. The operating formulas for fighter slip corrections are:

$$\boxed{\beta_a = A\cdot\alpha} \qquad (22)$$

$$\boxed{\beta_o = A\cdot\beta} \qquad (23)$$

4. In accordance with operating formulas (18), (19), (20), (21), (22), (23) we obtain the operating formulas for total angular corrections:

$$\phi\Sigma_{\text{В}} = \left[\omega_{\text{ЦВ}} - (\mu - 1)\,\phi_{\text{В}}\right]\cdot T' - P\cdot\omega_{\text{СВ}} \cdot T' + a'T + B' + A\cdot\alpha$$

$$\phi\Sigma_{\text{Г}} = \left[\omega_{\text{ЦГ}} - (\mu - 1)\,\phi_{\text{Г}}\right]\cdot T' - P\cdot\omega_{\text{СГ}} \cdot T' - P'\cdot\omega_{\text{СГ}}\, T' + A\cdot\beta$$

But $\omega_o = \omega_{\text{Ц}} + \phi$, so we have:

$$\phi\Sigma_{\text{В}} = \left(\omega_{\text{ЦВ}} - \frac{\mu-1+P}{1-P} \cdot \phi_{\text{В}}\right) T'\,(1-P) + a'T + B' + A\cdot\alpha$$

$$\phi\Sigma_{\text{Г}} = \left(\omega_{\text{ЦГ}} - \frac{\mu-1+P-P'}{1-P-P'} \cdot \phi_{\text{Г}}\right)(1-P-P')\cdot T' + A\cdot\beta$$

Marking $\frac{\mu-1+P}{1-P} = K_{\text{В}}$ and $\frac{\mu-1+P-P'}{1-P-P'} = K_{\text{Г}}$,

we arrive at:

$$\phi\Sigma_B = (\omega_{\text{ПВ}} - K_B \cdot \phi_B)\cdot T + a'T + B' + A\cdot\alpha$$

$$\phi\Sigma_\Gamma = \frac{1-P-P'}{1-P}(\omega_{\text{ПГ}} - K_\Gamma \cdot \phi_\Gamma)\cdot T + A\cdot\beta$$

In sight АСП-5НД $K_B = 0.2$ and $K_\Gamma = 0.4118$.

The operating formulas for the total correction appear as:

$$\boxed{\phi\Sigma_B = (\omega_{\text{ПВ}} - 0.2\phi_B)\cdot T + a'T + B' + A\cdot a} \quad (24)$$

$$\boxed{\phi\Sigma_\Gamma = 0.85\,(\omega_{\text{ПГ}} - 0.4118\phi_\Gamma)\cdot T + A\cdot\beta} \quad (25)$$

The components of the lead angle are constructed by the main gyro with participation of the zero gyro.

The variable portion a'T of the elevation angle vertical component and aircraft slip correction $A\cdot\beta$ are constructed together with the respective components of the additional lead angle through the employment of the zero gyro.

The values of coefficient a' for different ballistic characteristics are as follows:

HP - 30	a' = 0.24
APC-57M (C-5M)	a' = 0.29

The constant portion B' of the elevation angle vertical component is constructed together with the aircraft angle of attack correction through turning the plano-parallel plate (corrections are computed only for PC rockets).

The values of coefficients B' and A for different ballistic characteristics are as follows:

APC-57M	(C-5M)	A = 0.75	$B' = 0.267^\circ$
KAPC-57	(C-5K)	A = 0.54	$B' = 1.8^\circ$

When firing with rockets C-5k, used against ground targets, the average value of α equal to $\alpha_{op} = 1.767^\circ$ is introduced into the sight, whereas the elevation angle vertical component and angle of attack correction are compensated for by the expression $B'+A\cdot\alpha_{op}$ which introduces their constant values.

The operating formulas for indicated time T appear as:

$$\boxed{T = A + \varphi(Д_0)\, f(H)} \qquad (26)$$

For different ballistic characteristics expression (26) has the following meanings:

$$T_{30} = 0.5 + \varphi(Д_0)_{30} \cdot f(H)_{30},$$

where $\varphi(Д_0)_{30} = 1.22 \cdot \varphi(Д_0)_{HO} - 0.2162$

$$f(H)_{30} = f(H)_{HO} - 0.225$$

$$\varphi(Д_0)_{HO} = 1.81Д - 0.49 \text{ (when } Д \leq 0.6 \text{ km.)}$$

$$\varphi(Д_0)_{HO} = 0.6Д^2 + 1.09Д - 0.274 \text{ (when } Д \geq 0.6 \text{ km.)}$$

$$f(H)_{HO} = 1.248 - 0.0554 \cdot H + 0.00148H^2 \text{ (H, km.)}$$

$$T_{5M} = 1.05 + 1.3055 \cdot \varphi(Д_0)\, po\, [f(H)po - 0.321]$$

where:

$$\varphi(Д_0)po = 0.27035 \cdot Д^2 + 1.7057 \cdot Д - 0.6472 \text{ (Д, km.)}$$

$$f(H)po = 1.2159 + 0.00052947 \cdot H^2 - 0.032325 \cdot H \text{ (H, km.)}$$

In case with rockets C-5K the indicated time is considered to be constant and equal to T = 3 sec.

3. SIGHT FUNCTIONAL DIAGRAM AT FIRING MODE OF OPERATION

The final result of the sighting process during air shooting is the construction of the total angular correction composed of the lead angle, elevation angle, and correction for aircraft slipping (when firing rockets).

Fig.14 represents the functional diagram of the sight operation in case of firing rockets; Fig.15 represents the functional diagram of the sight operation in case of cannon firing.

Solid lines in the diagram are used to indicate electrical connections, dash and dot lines – mechanical connections, dotted lines – assemblies and units that are not included into the sight complete set.

Г – sight main gyro;

НГ – sight zero gyro;

УНГ – zero gyro amplifier;

МК and ИД - magnetic corrector and inductive transmitter of zero gyro;

ДУАС - attack and slip angles transmitter;

$\alpha_{ат}$ and β - angle of attack and slip angle;

$Д_0$ - initial range to target;

H - flight altitude;

T - computed time;

$\omega_Ц$ and ω_c - angular velocities of the line of sight and of the fighter;

Б - target wingspan (base);

d - angular size of the reticle diameter of the outer-base optical range finder;

J const - 22-V voltage, D.C. supplied to the main winding of the zero gyro magnetic corrector;

$J_{возб}$ - 115-V voltage, A.C., 400 c.p.s. supplied to the exciting winding of the zero gyro inductive transmitter.

The diagrams show that to solve the fire control problems the following parameters are to be fed into the sight: relative angular velocity of the target $\omega_Ц$; fighter angular velocity ω_c; initial range to target $Д_0$; flight altitude H; angle of attack $\alpha_{ат}$; slip angle β and ballistic characteristics of the weapon. To measure the range by the outer-base optical range finder, the target wingspan Б (base) is to be fed into the sight.

Target relative angular velocity $\omega_Ц$ is measured by the sight head gyro unit only in conditions of continuous following the target by the line of sight, as in this case the angle, through which the gyro axis deflects from the fighter fore-and-aft axis, is proportional to the angular velocity of the target.

Fighter angular velocity ω_c is computed by the zero gyro with the amplifier. Angular velocity ω_c is fed into the sight computing circuit in the form of current proportional to ω_c.

Range $Д_0$ is measured by the radar ranging unit or by the outer-base optical range finder and is introduced into the sight in the form of voltage depending on $Д_0$.

Altitude H is measured by the barometric altitude trans-

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mitter and fed into the sight in the form of resistance which is a function of H.

Angles of attack $\alpha_{\text{ат}}$ and slip angles β are measured by ДУАС and are introduced into the sight in the form of voltages depending on $\alpha_{\text{ат}}$ and β.

The projectile ballistics is compensated for by rated resistors connected to the appropriate portions of the computing circuit.

The target wingspan (base) is introduced into the sight manually by turning the lever of the base potentiometer. In so doing, the resistance proportional to the target wingspan, is fed into the computing circuit.

The most of the sight input parameters as well as sight operating voltage, generated by the proper transmitters and power sources, are fed into the distributor where the electrical circuits are commutated.

Using the fed parameters, the sight computing units compute the following values:

(1) computed time T;
(2) angular correction for target prediction;
(3) elevation angular correction;
(4) angular correction for fighter slipping (only for PC rockets).

4. FIRING AT GROUND TARGETS

Firing at ground targets with the employment of sight АСП-5НД has no principal differences from firing at airborne targets. The only difference is that when firing C-5K rockets the target range is not measured and time Tp as well as elevation angles are assumed to be constant (Tp = 3 sec.).

Besides, when delivering fire at ground target, the sight computes the vertical component of the fighter slip correction, which is a function of the angle of attack rated for certain firing conditions. When firing at ground targets, the angle of attack equals: $\alpha_{op} = 1^{\circ}46'$. The total elevation angle and correction for the average

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angle of attack equal $2^{\circ}49'$ (when firing with KAPC-57 (C-5K) rockets.

The above correction corresponds to the following firing conditions:

Flight altitude H = 600 m.;

Range to target Д = 1200 m.;

Diving angle λ = 30°.

Fighter speed V_1 = 750 km/hr.

Chapter IV

SIGHT MAIN UNITS, THEIR PRINCIPLE OF OPERATION AND FUNCTIONING

1. MAIN GYRO

In sight АСП-5НД the angular velocity is measured and the lead angle is computed by means of a free gyro. Gyro is a rapidly spinning symmetrical body (rotor) possessing one fixed point. Gyro has a property to keep its orientation in space constant, provided no external forces are applied to it. Being acted by the moment of external forces tending to turn the gyro about some axis misaligned with the spin axis, the gyro will rotate in the plane perpendicular to that moment. This movement of the gyro is called precession. The direction of precession is determined by the following rule: when the external force direction is turned through 90^0 about the gyro spin axis in the direction of rotor spinning, the direction of force will indicate the direction of precession (N.E. Zhukovsky's rule).

The main gyro is intended to compute the angle of lead.

The gyro construction is presented in Fig.16.

The gyroscopic unit consists of two main parts: a gyro proper and an electromagnet. The gyro proper consists of axle 2, one end of which mounts dome 4, the other end - mirror 1 in a special mounting. The gyro is freely suspended from pulley 12 by gimbal 13. The pulley is driven by the electric motor through spring belt 11.

The gimbal ensures three degrees of gyro freedom: gyro rotor can rotate in the vertical and horizontal planes about the respective axles of the gimbal and is spinning about its own axis. Point 0, where the gimbal axes intersect, is

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located on the gyro spin axis and coincides with the gyro rotor C.G. and with the centre of the dome spherical surface.

The electromagnetic unit consists of housing 8 (manufactured in the form of a sleeve), four cores 6, and cover 3 with pole 5. The sleeve, cores and cover with pole are made of permalloy possessing adequate magnetic conductivity. Cores 6 and pole 5 are arranged opposite to each other looking as if one continues the other. In the gap between them a gyro dome is placed. Arranged between the sides and cores of housing 8 is a main coil with winding 10. The second portion of winding 10 is wound on pole 5. Wound on winding 10 is negative winding (Ky_3) 9.

Cores 6 carry four additional coils of gyro correction with windings 7.

The electromagnetic unit is intended to create forces acting on the gyro.

When current flows through the winding of the main coil, a magnetic field is developed in the space around the winding, i.e. magnetic lines of force arise. The more is number of turns and current intensity, the stronger is the magnetic field. The magnetic lines of force of the coil field are always closed when leaving the coil or entering it. Therefore, the magnetic field produced by the main coil has the shape of four closed magnetic fluxes. Each magnetic flux flows through the core, cuts the gap between the core and the pole, and hence, the gyro dome, and is closed through the cover and housing.

The electromagnetic unit provides for a complete symmetry of the four cores in relation to axis AA which is the axis of the electromagnetic system.

Fig.17 represents four magnetic fluxes intersecting the gyro dome. When the magnetic lines of force are cut by the rotating gyro dome, made of an electro-conducting material (aluminium), small currents, known as eddy currents, appear in the points of intersection. The magnetic field developed by these currents interact with the original magnetic field (oppose it), hence, a force is set up in the point of gyro dome cutting the magnetic flux, which opposes the dome rotation.

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So, the interaction of the eddy current magnetic fluxes with the electromagnetic unit magnetic fluxes gives a rise to forces acting on the gyro dome, i.e. on the axle of the gyro rotor. These forces are presented in Fig.17 and marked as P_1, P_2, P_3, and P_4. The magnitude of each force is a function of the magnetic flux flowing through the core, and of the linear speed at which the gyro dome cuts this flux. The following relationship exists between the mentioned values:

$$P = K\Phi_0^2 \cdot V$$

where

Φ_0 – magnetic flux;
V – linear speed at which the dome cuts the magnetic flux (due to gyro spinning);
K – proportionality factor.

The magnetic flux depends on the number of coil turns and on the intensity of the current flowing through it:

$$\Phi_0 = K_1\, I \cdot W$$

where

I – current intensity;
W – number of turns;
I·W – ampere-turns of the coil;
K_1 – proportionality factor.

Dome linear speed V under the poles depends on the angular velocity of the gyro spinning Ω and on distance a – the distance from the gyro axis to the core centre. This speed equals:

$$V = a \cdot \Omega$$

Then the relationship for force P becomes:

$$P = aN\,(I \cdot W^2),$$

where $N = KK_1^2\Omega$ – proportionality factor.

This means that each of the four forces P_1, P_2, P_3, P_4, which oppose the dome rotation, is proportional to the square of ampere-turns in the coil and to the distance from the point of force application (core centre) to the gyro axis. When the axis of the magnetic system coincides with

the gyro axis, all the four forces are equal as the magnetic fluxes and distances a are equal. Hence, the dome is acted upon by four forces equal in magnitude and equidistant from the spin axis (Fig.18) which do not produce the resultant force, but create the braking moments overcome by the gyro electric motor.

When the axis of the magnetic system misaligns with the gyro axis (gyro axis ZZ is turned clockwise in plane XZ – plane of horizontal cores – through angle φ in relation to magnetic system axis AA), forces P as well as distances a are not equal (Fig.19).

At this condition:

$$a_4 = a_2,\ a_3 > a_1,\ P_4 = P_2,\ P_3 > P_1.$$

The resultant of force P' exceeds zero and is directed along the straight line parallel to axis YY to the side of greater force P_3.

This resultant acts on the gyro and makes it process in the plane perpendicular to the force direction, to the side of the greater force, i.e.force P_3 (Fig.19).

When the gyro processes, it tends to align its axis with magnetic system axis AA.

The more is mismatching angle φ (in Fig.19 – distance AA – ZZ), the greater is resultant P', and, hence, the angular velocity of the gyro precession.

When the amount of angle φ becomes less, force P' and gyro precession velocity decrease. With angle $\varphi = 0$, $P' = 0$ and $\omega_{\text{пр}} = 0$. Hence, the force, acting on the gyro, and the gyro precession angular velocity are proportional to mismatching angle φ and to the square of ampere-turns.

$$P' = F(IW)^2\varphi$$

The moment of resultant force P':

$$M_p = F_1(I \cdot W)^2\varphi$$

Moment M_p is counterbalanced by gyroscopic moment M_r:

$$M_r = F_2 \cdot \omega_{\text{пр}}$$

[redacted]

As the moments are equal, we arrive at:

$$\omega_{\text{пр}} = F_3 \, (I \cdot W)^2 \cdot \varphi$$

F, F_1, F_2 and F_3 – coefficients.

Marking $F_3 \cdot (I \cdot W)^2 = A$, we have: $\omega_{\text{пр}} = A \cdot \varphi$,

wherefrom $\varphi = \frac{1}{A} \cdot \omega_{\text{пр}}$

Thus, at a constant magnetic flux mismatching angle φ is directly proportional to the angular velocity of gyro axis spinning. The gyro axis precesses in the direction of the gyro frame rotation lagging behind from the frame axis of symmetry through angle φ.

Therefore, such gyroscopic systems have been termed systems with lagging gyro.

The magnetic system cores of the gyro unit are provided with additional coils which create an additional angle of deflection of the gyro axis from the aircraft fore-and-aft axis. When the current flows through the windings of the additional coils, the magnetic field is developed around them, which interacts with the main coil magnetic field. The windings of the additional coils are so connected that the main magnetic flux of one core decreases while that of the opposite core increases. The magnetic fluxes of the opposite cores being unequal, the gyro will be acted upon by the forces which are also unequal. The resultant of these forces acts on the gyro making it precess. The gyro will precess till the resultant of all the forces equals zero. As a result of the precession, the gyro axis deflects through a certain angle $\varphi_{\text{доп}}$.

Fig.20 represents the scheme of forces acting on the gyro when the current flows through the windings of the vertical additional coils at the following conditions:

$\varphi = 0$ (Fig.20a) $\quad \varphi = \varphi_{\text{доп}}$ (Fig.20b)

The value of the additional angle of the gyro axis deflection depends on the correlation between the main and

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additional magnetic fluxes or, which is the same, on the correlation between the ampere-turns of the main and additional coils.

The larger is the current flowing across the windings of the additional coils and the more is the number of the coil turns, the greater is the angle through which the gyro axis deflects. As the magnetic system cores are arranged by pairs in the vertical and horizontal planes, the additional angle is constructed by the sight in the form of two components. If the current in the gyro additional windings is changed as a function of the aircraft angular velocity and value T' (function T), the additional angle will be constructed in accordance with the following relationship:

$$\phi_{доп} = P \cdot \omega_0 \cdot T'$$

The total angle of the sighting line deflection should be:

$$\phi = \phi_{осн} - \phi_{доп} = (\omega_ц - K^x \phi)\ T$$

The current in the main coil is changed as a function of T by using potentiometer Π_7 whose brush travels proportionally to time T. The connection diagram of potentiometer Π_7 and of the gyro main coil (consisting of two parts: K_{y_1}, and K_{y_2}) is presented in Fig.21.

K_{y_1} – first portion of the main prediction coil (wound on the pole of the gyro cover).

K_{y_2} – second portion of the main prediction coil (wound together with coil K_{y_3} on a brass frame).

R_{73}, R_{073}, R_{77}, R_{077} – fixed resistors.

R_{T_1}, R_{T_2}, R_{T_3}, R_{78} – compensating resistors (for temperature compensation).

K – reference connector terminals to measure the prediction current.

Resistors R_{78}, R_{73}, R_{077} are arranged in the control box; R_{073} and Π_7 – in the computer, and R_{77} · in the sight head.

In the operating gyro the allowance should be made for different outside moments, acting on the gyro (ventilation moment, friction in bearings, etc.). Due to these moments, the instrument error in computing angle ϕ may extremely vary in various sights. To make allowance for the outside moments, each gyro is furnished with coil K_{y_3}, whose magnetic flux opposes the main coil magnetic flux and may vary in magnitude. To control the current flowing through coil K_{y_3} adjusting resistors R_{30} and R_{030} are incorporated in the sight head.

2. ZERO GYRO

The zero gyro is intended to measure and to transmit aircraft turn angular speed ω_0 whose vector is arbitrarily directed in the plane normal to the gyro axis.

The speed is measured in the wing plane and in the aircraft symmetry plane to obtain its horizontal and vertical components.

The zero gyro differs from the gyro dealt with in the previous section and used for computing lead angle in that it is provided with an inductive transmitter of mismatching angles between the axes of the aircraft and the gyroscope.

Fig.22 shows the diagram of the zero gyro for measuring the vertical component of the aircraft angular speed.

The horizontal component of the angular speed is measured by means of a similar circuit arranged in the plane normal to that discussed above.

As in the previous case, one end of zero gyro axle 5 carries aluminium dome 4 with electromagnetic correction system unit (MK) placed opposite. Main coil 1 of the magnetic device is similar to the main coil of the sight head gyro, but is supplied with D.C. voltage; consequently, the magnetic flux Φ_0 of the poles is permanent.

Correction coils 2 located on the cores of the magnetic correction device are series-connected in pairs. They are cut in in such a way that one coil of the pair decreases the main magnetic flux of the system while the other increases it.

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The other end of the gyroscope axle carries armature 6 made of permalloy. Placed opposite the armature is the inductive transmitter ИД. The latter is a four-pole system, each pole being made as П-shaped magnetic conductor 8. Fitted onto the magnetic conductor cores are eight coils with windings. Four of coils 7, set on four magnetic conductors are primary excitation coils connected in series, their free ends being connected to the A.C. source. Remaining four coils 9 (secondary coils) are series-connected in pairs but directed in opposition, their free ends being connected to the input of the zero gyro amplifier УНГ.

Angular speed ω_c is measured as follows.

With the gyro set to the zero position, the inductive reactances of the circuits formed by the coils of two opposite cores of the inductive transmitter are equal, and the secondary windings of these coils produce voltages equal in value but having opposite phases. In this instance, the total voltage supplied to the amplifier input has the zero value and there is no current induced in the magnetic coils. Thus, the moment acting on the gyro equals zero.

When the aircraft turns with certain angular speed ω_0, the gyro spin axis starts lagging behind the aircraft axis and, hence, behind the magnetic system axis, and a mismatching angle grows. This disturbs the equality of the reactances of the circuits formed by two opposite cores of the inductive transmitter, as the portions of the core poles overlapped by the armature are different. Therefore, the voltages induced by the secondary windings of the inductive transmitter are different too. The output of the inductive transmitter yields the voltage difference that is delivered to the phase-sensitive amplifier. The operation of the latter is described below.

From the amplifier output, the current flows to the magnetic corrector correction windings, its direction being dependent on the voltage phase across the amplifier input. The current appearing in the coils of the zero gyro and the current flowing in main coil 1 ($K_{НГО}$) create the moment generating the angular speed of the gyro precession.

The gyro spin axis deflection grows as long as the gyro precession speed is below the angular speed of the aircraft turn.

Simultaneously, the correction moment acting on the gyro, and the angular speed of the gyro precession will increase.

When the zero gyro spin axis has deflected from the inductive transmitter axis (aircraft axis) through a certain angle depending upon the aircraft angular speed, the correction moment reaches the value at which the angular speed of the zero gyro precession equals the angular speed of the aircraft turn. Thus, the moment or rather the correction current, the moment depends upon, serves as a measure of the angular speed. In case of small angles of the gyro spin axis deflection, the moment is practically a linear function of the current in the correction windings. Hence, the value of the correction current is proportional to the aircraft turn angular speed measured (the maximum angle of the zero gyro deflection does not exceed 30' that is why the gyro is called zero gyro).

As the angular speed of the gyro precession is equal to the angular speed of the aircraft turn, the relation of the gyro spin is expressed by:

$$H_1 \cdot \omega_{CB} = Б \cdot \Phi_0 \cdot \Delta\Phi_K,$$

where:

- H_1 – gyro kinematic moment;
- $Б$ – constant coefficient;
- Φ_0 – magnetic flux generated by the gyro main coil;
- $\Delta\Phi_K$ – flux created by the gyro correction coils.

The main coil of the zero gyro correction system receives the permanent voltage, therefore, magnetic flux Φ_0 is constant, too. From the above relation, magnetic flux $\Delta\Phi_K$ and thus the value of the current in the zero gyro correction coils are proportional to the aircraft turn speed:

$$I_{KB} = Б_1 \cdot \omega_{CB}$$

The current in the additional coils of the sight head gyro must be proportional to time T and ω_0:

$$I_{ДB} = B \cdot \omega_{CB} \; V\overline{T'} = B_1 \cdot \omega_{CB} \cdot V \cdot \overline{T}$$

Change of current $I_{ДВ}$ in the function of ω_{CB} is obtained by connecting the additional coils of the sight head gyro to the circuit of the zero correction coils where the current is proportional to ω_{CB}. The circuit of the additional coils is connected in series with the zero gyro correction coils, and, therefore, the current in the additional coils is proportional to ω_{CB}.

The current is multiplied by $\sqrt{T}$ by means of by-pass resistor $П_9$. The potentiometer resistance change law is taken so that the turn of the potentiometer slide proportional to T changes the current in the gyro additional winding according to the law:

$$I_{ДВ} = B_1 \cdot \omega_o \cdot \sqrt{T}$$

When the zero gyro is employed to compute a'. T component of the elevation angle, factor a' may be termed apparent angular speed. This angle is computed according to the principle true for the additional angle in the vertical plane when following up the lead angle.

While computing the a'· T component of the elevation angle, the zero gyro operates in the following way.

Apart from the correction windings, the vertical poles of the zero gyro magnetic correction device carry additional windings 3 ($K_{НГП}$) which pass the current proportional to factor a'. In this event, the gyroscope is actuated by a moment that deflects the zero gyro spin axis. When the gyro spin axis deviates, the vertical channel secondary windings of the inductive transmitter produce the voltage difference delivered to the zero gyro amplifier. The current proportional to value a' is fed to correction coils 2 ($K_{НГВ}$) from the amplifier output. In this instance, the moment acting on the gyro due to the current running in coils 3 ($K_{НГП}$) is balanced by the moment due to the current running in coils 2 ($K_{НГВ}$), and the gyro axis will deflect through a definite angle.

The zero gyro functions differently when computing the additional angle of lead and the vertical component of the elevation angle. In the first case, the aircraft angular speed induces currents in the zero gyro correction coils,

and in the second case, the moment created by the additional coils of the zero gyro induces the currents, i.e. when computing the vertical component of the elevation angle the apparent angular speed is created as if by additional coils of the zero gyro and is proportional to factor a'.

Thus, in the case of the aircraft angular speed in the vertical plane, and with the $К_{НГП}$ circuit energized, the vertical correction coils of the zero gyro pass the current proportional to the sum of speeds:

$$I_{КВ} = Б_1 (\omega_{СВ} + a').$$

The sight head gyro deflects in the vertical plane through additional angle $\Phi_{ДОП}$ and through the variable component of elevation angle a'·T.

Different ballistics require different current proportional to factor a', and the change is obtained by cutting in ballistic resistors connected in series with coils 3 ($К_{НГП}$). In the case of cannons, the resistors are connected by means of relay contacts P_{2-5}; in the case of rockets, by means of setting a proper ballistic unit and cutting in relay contact P_{3-6}.

The sight has two channels for connecting the additional coils as the zero gyro measures the two components of the aircraft turn angular speed. The horizontal channel differs from the vertical channel in that:

(1) The horizontal channel is provided with additional coils $К_{НГС}$ (instead of coils $К_{НГП}$) used for computing the horizontal component of the aircraft slip correction and for checking the horizontal channel serviceability by means of checking unit КП5СД.

(2) Resistor R_{215} is connected to the vertical channel circuit by the contacts of relay P_{15-2}. When the damping button is depressed, relay P_{15} operates and 22-V voltage is supplied to the vertical correction circuit through resistor R_{215}.

This provides for maintaining the average value of the elevation angle vertical component, hence, the time,

necessary to construct the elevation angle, is reduced (with the damping button being released).

(3) The additional angle computed by the horizontal channel is greater than that computed by the vertical one (refer to computing the angle of elevation). For this purpose, the correction current in the horizontal channel is increased due to decreasing the number of turns in the coils $К_{НГГ}$:

$$I_{КГ} = B_2 \cdot \omega_{СГ}$$

The current in the additional coils of the sight head gyro is $I_{ДГ} = B_2 \cdot \omega_{СГ} \cdot V \cdot \overline{T}' = B_3 \cdot \omega_{СГ} \cdot V \overline{T}$.

The current proportional to $V \overline{T}$ is changed by means of potentiometer $П_8$.

Resistors R_{203}, R_{0203}, and R_{49} are used to change the current in coil $К_{НГО}$ when doing adjustment.

Adjusting resistor R_{48} is intended for regulating the current in the sighting coils.

Resistor R_{47} serves for obtaining the rated resistance of the sighting circuit needed for precise operation of the circuit when changing the ballistics.

Absorbing resistor $R_{Д}$ is connected in series with the inductive transmitter excitation windings.

Resistor R_{216} is used for adjusting the $К_{НГС}$ coil circuit.

Capacitors C_1^x, C_2^x, C_5, C_6 are high frequency filters.

All the above components are arranged in the zero gyro, resistors R_{47} and R_{48} being placed in the control box.

Potentiometers $П_8$ and $П_9$ are located in the computer time unit, their sliders moving simultaneously with follow-up of time in the ballistic bridge by means of potentiometer $П_1$.

Adjusting resistors R_{53}, R_{63} are also placed in the computer, resistors R_{57}, R_{178}, R_{67}, R_{188}, R_{057}, R_{067}, R_{215} being mounted in the control box. Resistors R_{057} and R_{067} are ballast loads for the amplifier horizontal and vertical channels respectively.

Sight head gyro additional windings $К_{КГ}$, $К_{КВ}$ are accomodated in the sight head.

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3. ZERO GYRO AMPLIFIER (УНГ)

The zero gyro amplifier (УНГ) is an electron amplifier comprising two independent channels of a similar design. Each channel amplifies signals in proportion with the horizontal or vertical component of speed ω_0.

The amplifier generates the correction currents proportional to its input voltages which the zero gyro inductive transmitter feeds to the amplifier horizontal channel along wires 002 and 126, and to its vertical channel, along wires 002 and 125 (Fig.23).

The direction of the current at the amplifier output for every channel is determined by the voltage phase which in turn depends on the direction of the zero gyro armature deflection and, hence, on the direction of the angular speed.

The current intensity at the amplifier output is proportional to the input voltage amplitude which is in turn proportional to the deviation angle of the zero gyro armature and thereby to the angular speed value.

Wires 61, 69 of the horizontal channel carry the correction currents fed from the amplifier output to the zero gyro correction windings $K_{НГГ}$ and to the additional windings $K_{КГ}$ of the sight head, and wires 71, 79 of the vertical channel, to windings $K_{НГВ}$ and $K_{КВ}$, respectively.

Every channel of the amplifier comprises two stages: A.C. voltage amplification stage and the power amplification stage, the latter serving at the same time as a phase-sensitive rectifier. The stages are connected by transformer-type connection.

The voltage amplifier for every channel utilizes half of valve $Л_5$ (twin triode 6Н1П).

Interstage transformer Tp-2 serves as a load for the horizontal channel of the voltage amplifier, and transformer Tp-3 for the vertical channel.

The anode circuits of the voltage amplifiers of both channels receive 120 V D.C. from the full-wave rectifier based on valve $Л_6$ (kenotron 6Ц4П).

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<u>Rectifier Circuit.</u> The diodes pass the current in one direction only. This property is employed for rectification of the A.C.

The rectifier function is to apply A.C. voltage to the valve anode. At the same time, the load passes the current of constant direction.

The voltage amplifier supply system employs the full-wave rectification circuit based on double-anode kenotron 6Ц4П.

Voltages at the ends of windings Tpl-VIII are 180^{o} out of phase. They are delivered to the rectifying valve anodes.

During each half-cycle of the voltage rectification process the current passes only through the part of the valve whose anode has received the positive voltage.

From the transformer winding, the current flows to the valve anode, passes through the filter resistor R_1, load (voltage amplifier based on valve $Л_5$) and reaches the transformer winding centre tap.

Fig.24 shows curves 1 and 2 of the voltage change across the valve anodes, 180^{o} out of phase.

Curves 3 and 4 show change of the current passing through one and the other anodes, respectively, curve 5 indicating change of the total current in the valve cathode circuit.

The ripple current is smoothed by a filter made up of two capacitors and resistor R_1. The direct component of the rectified current flows through resistor R_1 and the load to the centre tap of the winding of transformer Tpl-VIII.

The A.C. component of the rectified current closes to the centre tap of the winding of transformer Tpl-VIII through the capacitor.

The grid of triode $Л_5$ controls the value of the anode current. In this instance, the grid receives the voltage of required value and sign. When positive potential (relative to the cathode) is supplied to the grid, the speed of the electrons moving from the cathode to the anode increases, thus increasing the anode current.

The negative potential applied to the grid decelerates the travel of the electrons towards the anode. In this event, the anode current decreases and may come down to zero.

Thus, the grid serves as a control electrode whose potential is changed to govern the anode current.

The grid of valve $Л_5$ receives two voltages: bias voltage U_0, generated by anode current flowing along resistor $R_4(R_8)$ and voltage $U_{вх}$ from the zero gyro inductive transmitter.

Capacitor $C_3(C_5)$ is intended to smooth the ripple voltage generated by resistor $R_4(R_8)$.

The grid receives the negative bias voltage through grid leak resistor $R_3(R_7)$.

Operation of the horizontal amplification channel is dealt with below.

The anode current changes if the grid receives voltage U_{BX} of different signs fed by the zero gyro inductive transmitter.

The anode current in the primary winding of transformer Tp2-I changes to transform increased voltage in the secondary windings of transformers Tp2-II and Tp2-III proportional to the voltage running from the zero gyro inductive transmitter. Capacitor C_{13} is a filter of high frequencies decreasing their effect on the next stage.

Power amplifier. The power amplifier is based on valves $Л_1$ and $Л_2$ (twin triodes of 6H12C type) for the horizontal channel, and on valves $Л_3, Л_4$ for the vertical channel. The anode circuits of the valves of the horizontal channel power amplifier are fed with 230 V A.C. from the winding of power transformer Tpl-II.

Negative bias (-30 V to -40 V) is supplied to the grids of valves $Л_1$ and $Л_2$ so that the anode currents across the grids approximate to zero when the grids of valve $Л_5$ are free, from individual selenium rectifiers BC-1, BC-2 of the BCM type fed with A.C. voltage from the windings of transformer Tpl-IV, Tpl-V. The selenium rectifiers are connected so that the circuit of resistors ДС-1000, R_9 (R_{11}) passes the current in one direction only and these resistors decrease the voltage delivered (with the plus sign) to the cathode and (with the minus sign) to the grids of the respective valves through transformers Tp4-II,

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Tp2-II (Tp4-III, Tp2-III). Capacitors C_6, C_7 are intended for smoothing the ripple current flowing from the amplifiers.

Adjustable resistors DC-1000 connected to the circuit of the valve cathodes serve for regulating the output currents due to automatic bias delivered to the valve grids and for regulating the value of the negative feedback.

The power amplifier is assembled so that the grids are in the phase, and the anodes - in antiphase. Let us assume that points H on the windings of the transformers Tpl-II, Tp2-II, Tp2-III yield positive potentials at the given moment, and points K - negative potentials. In this instance, the grids of valves $Л_1$, $Л_2$ receive positive potential, anodes of valve $Л_2$ - positive potential, too, and anodes of valve $Л_1$ - negative potential. The anode current flows through valve $Л_2$, as positive potentials are applied simultaneously to the anode and to the grid of the valve in question. Both valves of this stage supply current to the common load (resistor R_6, correction circuit comprised of coils $K_{НГГ}$, $K_{ГГ}$ and other resistors) generating in it currents of the required direction depending on the valve anode and grid where positive potentials match. The matching depends on the phase of the signal sent by the zero gyro inductive transmitter to the amplifier input.

Discussed below are two cases of zero gyro amplifier operation.

Case 1 - angular speed of the aircraft is zero. In this instance, the armature of the zero gyro is placed symmetrically relative to the magnetic conductors of the inductive transmitter, and the secondary windings of the latter induce voltages of the same value but shifted 180° out of phase. The difference of the voltages is zero. No A.C. voltage is fed to the grid of valve $Л_5$, only D.C. voltage flows through the valve. The voltage across the windings of transformers Tp2-II and Tp2-III is zero. The current does not pass through valves $Л_1$ and $Л_2$, as the selenium rectifiers send to their grids the negative bias (-30 to -40 V) cutting the valves off.

Case 2 - the angular speed of the aircraft is other than zero. With the armature deflected from the gyro axle due to the aircraft angular speed, the grid of valve Л_5 receives A.C. voltage whose phase depends on the angular speed vector, and the amplitude - on its value. The ripple current flowing through valve Л_5 and the winding of transformer Tp2-I induces A.C. voltage in the windings of transformers Tp2-II and Tp2-III. If during the first half-cycle points H of the windings of transformers Tp2-II and Tp2-III and point K of the winding of transformer Tp1-II have positive potentials, valve Л_1 will pass the current and valve Л_2 will not, as the anode of valve Л_2 receives negative potential. The current will flow from point K (Tp1-II) to point H (Tp1-II) through transformer Tp4-I, resistor R_6, wire 69 and valve Л_1.

During the second half-cycle, points H of the windings of transformers Tp2-II and Tp2-III will have negative potentials delivered to the grids of valves Л_1 and Л_2 to improve their cutting-off. In this case there is no current in the correction circuit despite the positive potential is fed to the anodes of valve Л_2. During the next half-cycle, the current flows in the same order as during the first half-cycle.

Thus, flowing through valve Л_1 are separate pulses smoothed by capacitor C_{10} of great capacitance. In this instance, the direct component of the rectified current flows from wire 61 through resistor R_6 and the correction circuit to wire 69.

The angular speed vector changes to change the phase of the voltage supplied to the amplifier input. The positive potentials match on the anodes and the grid of valve Л_2 which delivers the current through the load in the opposite direction, i.e. from wire 69 to wire 61.

In both cases, the value of the current across the output is proportional to the input voltage amplitude.

Filament circuits of each valve of the zero gyro amplifier are made independent to prevent interelectrode puncture of the valves (cathode filament) during operation.

To make the zero gyro operation stable under the angular vibrations and to damp its mutation oscillations, the zero gyro amplifier employs the negative feedback in acceleration.

If acceleration is present, the value of the output current changes in proportion with the acceleration. When the changed current flows via the primary winding of the feedback transformer Tp4-1, the secondary windings of transformers Tp4-II and Tp4-III induce voltages proportional to the acceleration. These voltages are fed to the grids of valves $Л_1$ and $Л_2$ in opposition to the input pulse to decrease the voltages acting on the valve grids thereby decelerating the output current increase and making the gyro functioning steady.

The other channel of the amplifier functions in the same way.

4. ELECTRON RELAY PЭ

The electrical computing circuits of the sight (range follow-up circuit, time, reticle circle and plano-parallel plate angles of turn follow-up circuits) consume D.C. voltage. D.C. delivered to the electron relay input serves as a mismatch signal. The value and direction of this current depend upon the mismatch between the receiving and transmitting branches of the bridge. The output of the electron relay delivers 27 V to a winding of the electromagnetic reversible clutch so that the mean value of the current is proportional to the signal at the electron relay input. The amplification of the D.C. signal fed directly to the electron relay input involves a number of technical difficulties. Therefore, the electron relay of sight АСП-5НД employs the circuit where the D.C. mismatch signal fed to the input is amplified by the magnetic amplifier and converted to the A.C. signal whose amplitude is proportional to the mismatch signal value, the phase depending on the mismatch direction (direction of the current in the control winding of the magnetic amplifier). Then, this signal is amplified by the A.C. amplifier and fed to the phase-sensitive rectifier that governs the functioning of the vibration

amplifier. The vibration amplifier (polarized three-position relay) cuts in the appropriate winding of the electromagnetic reversible clutch 2PT-200 (P-200) ensuring the follow-up required. Every unit of the electron relay comprises two independent channels that in no way differ from each other. The electron relay unit arranged in the computer ensures the follow-up of the range and time. The electron relay assembled as a separate unit (Assy 8) ensures follow-up of the reticle size and of the vertical component of the aircraft slip correction.

In Fig.26 the letters stand to indicate:

МУ – magnetic amplifier intended to amplify D.C. signal and convert it into A.C. signal;

УНЧ – A.C. amplifier;

ФВ – phase-sensitive rectifier;

ВУ – vibration amplifier.

The relay has three negative feedbacks:

I – inner feedback of the vibration amplifier intended to create vibration conditions for functioning of the polarized relay and to uniformly change the output signal due to change of the signal across vibration amplifier input.

II – inner feedback between the vibration amplifier output and the magnetic amplifier intended to decrease the time constant of the electron relay РЭ.

III – outer feedback for speed between the tachogenerator of the electromagnetic reversible clutch 2PT-200 and the input of valve $Л_1$ of the A.C. amplifier intended to improve operation stability of the follow-up drive and to remove self-oscillations (Fig.28).

Magnetic Amplifier. The magnetic amplifier (МУ) serves to amplify D.C. (mismatch signal of the automatic follow-up system) and to convert it into A.C. whose phase depends upon the direction of the current in the control winding, and the value, upon the intensity of the current across the latter.

The magnetic amplifier utilizes a bridge circuit. The magnetic conductor of the amplifier is assembled of four packages of Mo-permalloy discs (I, II, III, IV) with the following windings:

I - excitation windings (Fig.27) 1, 2, 3, 4, each being arranged on the appropriate package. They create inductances L_1, L_2, L_3, L_4 and are connected to form a bridge circuit. One diagonal of this bridge receives 0.46 V, 400 c.p.s. from transformer Tp-3, the other being connected to output transformer Tp-I (Fig.29).

If inductances of these circuits are equal or equality $L_1 \cdot L_3 = L_2 \cdot L_4$ (balance of bridge) is observed, the bridge diagonal, the output transformer is connected to, yields no signal. In case the equality is disturbed, the bridge diagonal gets A.C. of a required amplitude and phase depending on whether $L_1 \cdot L_3$ is above or below $L_2 \cdot L_4$. The inductance value of every winding depends upon the total magnetic flux in the circuit of its magnetic conductor which is a sum of the magnetic fluxes of the magnetizing winding, correction winding, control winding and feedback winding.

II - magnetizing windings 5, 6, each comprising two packages. Windings 5, 6 pass magnetizing D.C. of 22 V inducting initial magnetic fluxes $\Phi_1, \Phi_2, \Phi_3, \Phi_4$. Windings 5 and and 6 are connected so that magnetic fluxes Φ_1, Φ_2, Φ_3, Φ_4 are equal in value and opposite in direction.

III - correction, control and feedback windings.

These are wound around all four packages of the cores so that they interact with the magnetic fluxes in every package.

In Fig.27 they are schematically shown as winding 7.

Correction winding 8 (Fig.28) is arranged to ensure balance of the bridge when control winding 7 is free from the signal.

Magnetic amplifiers fail to ensure equal inductive reactances of the bridge windings, and a signal appears across the bridge output. The value of this signal is reduced to minimum by applying D.C. to correction winding 8 from voltage divider R_{14}, R_{15} and adjusting resistor R_{12}; the value and direction of the current may be changed. The magnetic flux of this winding increases fluxes Φ_1 and Φ_3 produced by winding 5 and decreases fluxes Φ_2 and Φ_4 produced by winding 6, or does it vice versa. The inductances

of these windings change correspondingly, and the current is adjustable to obtain equality $L_1 \cdot L_3 = L_2 \cdot L_4$, i.e. bridge balance.

Control winding 7 of the magnetic amplifier is connected between the receiving and transmitting branches of the computing circuit. When current flows through winding 7, magnetic fluxes induced by this winding will increase one pair of fluxes Φ_1, Φ_3 and decrease the other pair of fluxes Φ_2, Φ_4, or vice versa, depending on the direction of the current in winding 7.

The magnetic fluxes are changed to change the inductances of windings 1, 2, 3, 4 (they are decreased in windings 2, 4 and increased in windings 1, 3, or vice versa depending on the direction of the current in winding 7), thus interfering with the bridge balance, and the magnetic amplifier output produces A.C. signal whose phase depends on the direction of the current in winding 7, and the value, on the current intensity across this winding.

Negative feedback winding 9 of the magnetic amplifier is arranged to decrease the electron relay time constant. This winding is fed with current through the contacts of the vibration amplifier.

Transformer Tp-1 mounted inside the housing together with the magnetic amplifier serves to match the magnetic amplifier output resistance with the A.C. amplifier input resistance.

A.C. Amplifier. The A.C. amplifier is a voltage amplification stage based on valve $Л_1$ (6Н1П) (Fig.29). The magnetic amplifier output sends voltage to potentiometer R_2 intended to adjust the relay sensitivity.

Capacitor C_1 compensates for the phase shifts of the magnetic amplifier output voltage and suppresses the higher harmonics. The slider of potentiometer R_2 delivers voltage to one of the grids of valve $Л_1$ for amplification of the the A.C. One triode of valve $Л_1$ is used in each channel of the electron relay to amplify A.C.

Resistor R_4 is the anode load of valve $Л_1$.

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Resistor R_3 and capacitor C_2 deliver the automatic bias voltage to the grid of valve $Л_1$. This voltage ensures functioning of the valve along the straight portion of its characteristic.

Both triodes of valve $Л_1$ are fed with voltage from the full-wave rectifier based on valve $Л_4$ (6Ц4П).

When A.C. voltage is delivered to the grid of valve $Л_1$, the valve anode current changes bringing about a respective change of voltage across the anode. From the valve anode, the amplified voltage is fed to the grids of phase-sensitive rectifier $Л_2$ through capacitor C_3.

Phase-Sensitive Rectifier is a twin triode, type 6Н1П; the grids of its both halves receive the signal from the preceding stage (valve $Л_1$). The anodes of valve $Л_2$ are fed with A.C. voltage from the step-up winding of the power transformer Тр-3 through the differential windings of relay P_1.

When there is no signal across the valve grids, every triode of valve $Л_2$ passes current pulses of the same value. Flowing along the windings of polarized relay P_1, these pulses are smoothed by capacitors C_4 and C_5, every winding inducing equal opposite directed magnetic fluxes. In this case, the armature of relay P_1 stands in the middle position. The phase of A.C. voltage applied to the grids of the phase-sensitive rectifier coincides with the phase of the voltage across one of the anodes of the valve and opposes the phase of the voltage across the other anode, depending on the direction of the current flowing along control winding 7. The current across the triode with the same phases of the anode and grid voltages increases, and that across the other triode, decreases. Relay P_1 functions due to the difference in magnetic fluxes.

Vibration Amplifier is three-position polarized relay P_1 (РЭ - Assy 41) with four windings. Two of them (control windings) are connected to the anode circuits of valve $Л_2$ as described above, the other two (feedback windings) supplying current by the contacts of the relay in question.

The feedback windings create vibration conditions for relay P_1. The vibration conditions are created in the

following way: the relay operates actuated by the current flowing through one of the windings connected to the anodes of valve $Л_2$ and the respective contacts of the relay close to send current through resistor R_8 or R_{10} and through one of the feedback windings.

The ampere-turns of the feedback windings oppose the ampere-turns of the main winding that makes the relay operate.

The intensity of the current in the feedback winding grows to exceed the magnetic flux of the main winding, and the relay contacts break. This involves breaking of the feedback winding circuit, while the ampere-turns of the main winding keep operating. As a result, the relay operates again to create vibration conditions for operation of relay P_1.

The time the relay contacts are closed is proportional to the intensity of the current flowing through the relay control winding. Consequently, the effective current, flowing through contacts, is proportional to the current, flowing through the control winding, which, in turn, is proportional to the input signal. These contacts feed the current to one of the windings of the reversible electromagnetic clutch whose power is proportional to the input signal (the proportion is not exact due to non-linearity of the electron relay circuit components). When the relay contacts are closed, the voltage passes through resistor R_7 or R_{11} (Fig.28) to one of the halves of negative feedback winding 9, depending on those relay contacts which are closed.

Follow-Up Drive comprises electron relay P3 and reversible electromagnetic clutch 2PT-200.

The negative feedback of the tachogenerator of the reversible electromagnetic clutch 2PT-200 is meant to ensure smooth and steady follow-up.

The signal of the negative feedback is fed to the input of A.C. amplifier valve $Л_1$ through transformer Tp-4. When the follow-up drive functions, D.C. signal appearing due to the potentiometer bridge mismatch is fed to the electron relay input. The electron relay output sends the amplified signal to the coil of clutch 2PT-200 causing the latter to operate. As the follow-up process starts, the tacho-

generator (TT) yields the negative feedback signal. This signal opposes the phase of the signal passing from the magnetic amplifier to the A.C. amplifier grid to reduce the latter signal by the value proportional to the follow-up speed so that the current across the electron relay output decreases enough to disconnect clutch 2PT-200 before the mismatch has been followed up. The shaft of clutch 2PT-200 decelerates, and the negative feedback signal decreases. The total signal on the grid of valve $Л_1$ increases to cause clutch 2PT-200 to operate again. As soon as the follow-up speed slightly increases, clutch 2PT-200 is disconnected again. The intermittent follow-up process will continue until the mismatch has been followed up, the follow-up speed gradually coming down.

This is the way to obtain the smooth follow-up of the drive maintaining the system highly sensitive and without self-oscillations.

Fig.28 shows the diagram of one channel of the electron relay together with clutch 2PT-200.

A number of circuit components is not shown in the diagram (e.g. rectifier, filament circuits, etc.). The detailed diagram of the electron relay is shown in Fig.29.

The electron relay circuit is fed with the following voltages:

27 V ±10% of D.C.;
22 V of stabilized D.C.;
115 V ±5%, 400 c.p.s. ±5% of one-phase A.C.

The A.C. voltage is fed to power transformer Tp-3. Connected to one of the transformer secondary windings are diagonals of the magnetic amplifier bridges. The power transformer Tp-3 supplies voltage to the voltage amplifier valve $Л_1$ through the rectifier using valve $Л_4$. The transformer supplies voltage to valves $Л_1$ and $Л_3$ and to the filament circuits of valves $Л_1$, $Л_2$, $Л_3$, $Л_4$.

22 V of stabilized D.C. are fed to magnetizing windings 5, 6 and correction winding 8 of the magnetic amplifiers.

The circuit of feedback winding 9 of the magnetic amplifier is fed with 27 V D.C. through the contacts of relays P_1 and P_2 (vibration amplifier).

Connected in parallel with the control windings are selenium rectifiers CB_1 and CB_2 which pass a part of the current when the current exceeds 20 μA (the mismatching signal being too great) to avoid the saturation of the magnetic amplifier.

5. ALTITUDE UNIT

The sight automatically computes the altitude by means of the aneroid capsules of unit ВД-28 (ВД-20).

The travel of the aneroid capsules driven by the potentiometer follow-up system is converted into an angle of turn of the sliders of potentiometers $П_2$ and $П_3$ introducing the value of the altitude function into the ballistic bridge (Figs 30 and 127).

Electric motor ДИД-0.5 of the follow-up system is linked with the contact disc, altitude scale and brushes of the altitude transmitting potentiometers by means of the reduction unit. The contact disc has two slip half-rings insulated from each other.

The control winding of electric motor ДИД-0.5 is fed from the winding of transformer $TP\text{-}1_{III}$ through contacts КВн (moving off the aneroid capsules), one of the slip half-rings and limit switch KB_{B1} (KB_{B2}). Capacitor C_7 shifts the voltage phase in the excitation winding through 90° relative to the voltage in the control winding. This shift is necessary for operation of the induction motor. Capacitor C_8 improves the operation of the induction motor when changing over contacts KB_H.

Contacts KB_{B1} and KB_{B2} disconnect the motor when the altitude reaches its extreme values thus protecting the mechanism from damage.

The altitude changing, contact KB_H clears the insulated portion to energize the winding of transformer $TP\text{-}1_{III}$ and the electric motor control winding via the slip half-ring and one of the contacts KB_{B1} (KB_{B2}). The electric motor starts rotating to set in motion disc 6 with slip half-rings, scale 1 and the brushes of altitude transmitting potentiometers 4 through the reduction unit.

The electric motor supply circuit is assembled so that the disc rotates in the direction required for bringing its insulated portion opposite contact KB_H. Once the insulated portion of the disc has come opposite the contact KB_H, the disc stops rotating, the electric motor supply circuit opens, and the system comes to standstill.

Thus, the transmitting potentiometers keep following up the altitude sent by the aneroid capsules.

Data of electric motor, type ДИД-0.5: rotation speed under no-load conditions:

at T within +20°C to +5°C .... at least 13,000 r.p.m.

Rotation speed under 3 gr-cm. load moment .... ≥ 7500 r.p.m.

Starting voltage:

at t = ±50°C .... not exceeding 0.4 V

at t = -60°C .... 0.8 V

Transformer Tp-1 is connected to 115 V, 400 c.p.s.

The electric motor excitation winding is connected to the winding of transformer $Tp\text{-}1_{II}$ producing 35 V; the control winding - to one of the half-windings of the transformer $Tp\text{-}1_{III}$ yielding 14 V each. The voltages in these half-windings are phase-shifted through 180°.

Unit ВД-28 is rated for operation up to 30-km. altitude.

All the above components are arranged in the altitude unit.

6. VOLTAGE REGULATOR CH-4

Voltage regulator CH-4 is intended to regulate the D.C. voltage applied to sight АСП-5НД. It stabilizes 22 V directly across the load with an accuracy of ±0.3 V.

The voltage regulation keeps accurate when:

(a) input voltage changes within 27 V ±10%;

(b) the load current changes within 1 - 3 A;

(c) air temperature changes from -60°C to +50°C;

(d) acceleration vibration reaches 3 g.

Note: Change of the output voltage up to ±0.5 V is admissible under t = -60°C.

The voltage regulator comprises coarse (static) and fine (astatic) adjustment units regulating the output voltage by changing the resistance of the carbon pile of the regulator. The regulator is connected in series with the load. It is sensitive to the difference between the input and stabilized voltages.

The output voltage is roughly adjusted by the carbon-pile regulator (winding K_1, the carbon pile and special mechanism).

The fine (astatic) adjustment is done by the circuit which feeds current of the required value to the additional winding of the electromagnet of the carbon-pile regulator K_2.

The pressure applied to the carbon pile additionally changes bringing the deviated output voltage to its rated value.

A. Circuit Diagram

Circuit diagram of the voltage regulator is shown in Fig.31.

The input voltage (27 V $\pm$10%) is applied to terminals 1' and 2' of the regulator connector. This voltage is consumed directly by series-connected filaments of two electron valves $Л_1$ and $Л_2$, type 13П1М (13П1С).

The input voltage is also fed to anode circuits of valves $Л_1$ and $Л_2$ connected in parallel with the additional winding K_2 of the carbon-pile regulator.

For checking the regulator operation and wear degree of the regulator carbon discs without interfering with the wiring, wire 03 is brought out to terminal 7' of the plug connector. Wires 01 and 03 are connected directly in the connector of the cable running to the regulator.

The output voltage is taken off connector terminals 3' and 2', wire 2 being common both for the input and output circuits.

The output voltage is generated by absorbing a portion of the input voltage across the carbon pile connected between terminals 1' and 3' of the connector. Capacitors C_{32} by-passing the carbon pile are mounted for damping the voltage oscillations.

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The output voltage (voltage across wires 1 and 2) is delivered to voltage divider R_{131} and R_{132} and to the valve screen grids.

Cathodes of valves $Л_1$ and $Л_2$ are connected to the voltage divider (wire 174) for creating negative bias on the valve control grids.

As the consumers require that the voltage delivered to them should be maintained constant, the circuit components determining the stabilization accuracy receive the voltage directly from the regulator output via wires 183 and 184 brought out to terminals 4' and 5' of the connector. This connection keeps the voltage stabilized free from the effect of the voltage drop in wires 1 and 2 depending upon the load current.

Resistor R_{139} = 1.7 ohms ±1% is intended to keep the output stabilized voltage within 22 ±0.3 V depending on the length of the mounting set. The resistor is made of copper and arranged in the sight head next to the gyro unit. Thus, resistor R_{139} ensures change of the output stabilized voltage as dependent on the temperature inside the sight head.

The voltage regulator uses a sensing unit. Its functioning is based on comparing the magnetomotive forces of the permanent magnet and of the electric magnet ensuring the required precision of the voltage regulation.

The sensing element (marked in dash-lines in Fig.31) is a voltage magnetoelectric relay specially designed for the purpose. It comprises permanent magnet M, electromagnet K_3 and movable frame P_{20} carrying middle contact KHP_{20}.

Magnetomotive forces of electromagnet K_3 and of permanent magnet M are subtracted from each other. The movable frame P_{20} whose winding passes the current is placed in the gap of the magnetic circuit formed by permanent magnet M and electromagnet K_3. It is held in the intermediate position by spiral springs delivering the current to the frame and to middle contact KHP_{20}.

Electormagnet K_3 connected in series with heat-compensat-

ing resistor R_{136} receives the stabilized voltage brought by wires 183 and 184. This voltage is also fed to frame P_{20}.

Movable frame P_{20} of the sensing unit compares the stabilized voltage (transformed by electromagnet K_3 into magnetomotive force of permanent magnet M which serves as a reference.

The system is designed so that when the voltage stabilized has its rated value, the magnetomotive forces of permanent magnet M and electromagnet K_3 are equal but run in the opposite directions, hence,the frame does not pass the magnetic flux. In case the voltage stabilized differs from the rated value, the difference of the magnetomotive forces of the permanent magnet and of the electromagnet creates the different magnetic flux which flows through the frame to affect its magnetic field and to turn the frame. In this event, contact KHP_{20} mounted on the frame closes with one of the fixed contacts.

Cut into the circuits of the three contacts KHP_{20} are limiter resistors R_{133}, R_{134}, R_{135} mounted inside the sensing units.

These resistors limit the charge-discharge current of capacitor C_{31} and determine the change speed of its charge. Resistor R_{133} is also a protective resistor designed to keep the frame springs against blowing out when they accidentally contact each other upon sharp jerks.

Capacitor C_{31} is connected to the circuit between the plus of the voltage stabilized (wire 183) and the control grids of the electron valves. This connection of the capacitor, when the voltage across the control grids depends directly upon the value of the current stabilized accelerates the stabilization process and prevents the automatic oscillations appearing in the regulation circuit due to introduction of the negative feedback.

The main coil K_1 of the carbon-pile regulator electromagnet consumes the stabilized voltage via wires 183 and and 184 and damping resistor R_{130}.

B. Voltage Stabilization Process

When changing the input voltage or the load, the process of stabilizing the output voltage passes two stages: rough and fine stabilization.

The rough (static) stabilization is done by the carbon-pile regulator.

When the voltage regulator operates, the sum of forces applied to the armature of the carbon-pile regulator electromagnet under the set conditions is nil. Change of the input voltage or of the load brings about change of the output voltage and, hence, the number of ampere-turns of winding K_1; the equilibrium of forces applied to the armature no longer exists. The resultant force of the springs, and the pulling force of the electromagnet shift the armature restoring the equilibrium of forces applied to it. The armature travels to change the pressure exerted on the carbon pile, bringing about change of its resistance and, consequently, its output voltage. Rough stabilization of the voltage is obtained when the forces applied to the armature are balanced. The feedback (capacitor C_{31}) accelerates the voltage stabilization process and improves the stabilization accuracy.

The fine (astatic) stabilization of the voltage is done by the sensing unit whose contacts charge or discharge capacitor C_{31} therby changing the potential across the control grids of the valves and the current in the additional winding K_2 of the carbon-pile regulator electromagnet. This additionally changes the resistance of the carbon pile and, thereby, the voltage stabilized. Once the voltage has reached its rated value, the charge of capacitor C_{31} stops changing due to opening of the sensing unit contacts KHP_{20}.

Under steady operating conditions (the input voltage and the load current being constant), the functioning of the regulator depends on the current across the valve grids and on the leak resistor of capacitor C_{31}. The output voltage regularly changes (within ± 0.3 V as from the rated value) as capacitor C_{31} gets gradually discharged through its own

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leak resistor and then charged through the sensing unit. This phenomenon is also observed when gradually charging capacitor C_{31} by the valve grid current and discharging it to the sensing unit.

7. PARAMETER AUTOMATIC FOLLOW-UP SYSTEM

The electrical computing systems of the sight are D.C. potentiometric bridge circuits, with electron relays used as sensitive units, and reversible electromagnetic clutches, as follow-up units.

Prior to proceeding to the description of electrical computing bridge circuits of the sight, the principle of the automatic follow-up must be explained.

The automatic follow-up system includes: transmitting potentiometer ПД (Fig.32), receiving potentiometer ПП, sensitive unit amplifying mismatch signals of the electron relay РЭ, and slave mechanism (electromagnetic reversible clutch 2РТ-200).

Potentiometers (voltage dividers) are units comprised of an ohmic resistor made of wire having high resistivity. Any portion of the voltage delivered to the ends of this resistor may be taken off the potentiometer by means of the moving brush (slider).

Potentiometers ПД and ПП are similar in design, the only difference being limit switches of potentiometer ПП which de-energize the electrical circuit of the electromagnetic reversible clutch when the potentiometer brush moves to its extreme positions. Adjusting resistors are employed to adjust the electrical circuits to the desirable parameter setting.

Slave mechanisms of the follow-up drives are reversible electromagnetic clutches 2РТ-200 (Fig.33). The clutch is provided with two coils 6 whose magnetic fluxes act on armature 11 with the disc. Arranged to the left and right of the disc are gears 5 driven by the electric motor. The gears rotate towards each other, the butt surface of each gear facing the armature being used to engage the latter. Two cork rings are glued to the disc to ensure

reliable engagement. The rotation is imparted to the clutch axle by the armature only provided it has engaged one of the gears. The armature can slide along the clutch shaft in the spline lugs. When the electromagnetic coils are de-energized, the clutch armature and the gears are disengaged.

The current flowing through one of the coils presses the armature to the respective gear rotating the axle. The sense of rotation depends on the coil passing the current. The axle transmits motion to the slider of the receiving potentiometer.

The duraluminium sleeve secured to axle 1 serves as an armature of the tachogenerator. The armature rotates in the magnetic field created by the tachogenerator excitation winding.

The latter consumes 400 c.p.s. voltage regulated within 0 to 6.3 V.

The secondary winding of the tachogenerator yields the voltage with the phase dependent upon the sense of the electromagnetic reversible clutch axle rotation, and the amplitude, upon its speed. This voltage is used as negative feedback of the follow-up drive.

Both windings of the generator are arranged on the stator. When the system operates, the transmitting potentiometer ПД feeds voltage $U_Д$ proportional to a certain value and compared with the voltage taken off the receiving potentiometer ПП. Voltage difference appearing when the above voltages have different values is indicative of mismatch signal. In this instance, the electron relay winding will pass the current whose direction and value are determined by the difference of voltages $U_Д$ and $U_П$.

The amplified mismatch signal governs the polarized relay accommodated in the electron relay РЭ. The polarized relay closes the circuit of one coil of electromagnetic clutch 2РТ-200, the armature being attracted to the corresponding gear. The axle of the reversible clutch receives rotation and the slider of the receiving potentiometer ПП moves to equalize $U_Д$ of the transmitting potentiometer and $U_П$ of the receiving potentiometer.

8. AUTOMATIC INTRODUCTION OF RANGE

When the range is introduced automatically, the radar ranging unit sends voltage $U_Д$ proportional to the range to the target.

The ranges yielded by the radar ranging unit and by the outer-base optical range finder are followed up by the same receiving potentiometer $П_{11}$ included into the bridge circuit (Fig.34).

The brush of potentiometer $П_{11}$ travels through an angle proportional to $Д_0$. Sliding together with the brush of potentiometer $П_{11}$ are brushes of transmitting potentiometers $П_4$ and $П_5$ included into the ballistic bridge, the brush of potentiometer $П_{16}$ included into the sight reticle circle bridge, and the brush of potentiometer $П_{17}$ included into the circuit of the range indicator.

When taking the range by the radar ranging unit, the receiving branch of the range bridge uses the reference voltage U_0 fed from the radar ranging unit through relay contacts P_{8-5}. The circuit of the bridge makes it possible to use radar ranging units, type СРД-5 or СРД-5МК (КВАНТ).

The radar ranging units have different initial voltages of the range and different gradients - changes of the voltage per 1-m. range. The bridge resistors are changed over to obtain different voltages of the initial range ($Д_0$ = 200 m.) and different gradients corresponding to the type of radar ranging unit employed.

In so doing, the output voltage of the СРД-5 (Base-6) and СРД-5МК (КВАНТ) radar range finders is in a reverse proportion to the target range. When the sight is operating in conjunction with the СРД-5 and СРД-5МК(КВАНТ) radar range finders, the elements of its receiving branch are connected in the way different from that of the sight operating together with other range finders, as in case with radar range finders СРД-5 and СРД-5МК the law of range voltage output is a diminishing (subsiding) one, i.e. with increase of range, voltage $U_Д$ decreases.

When ranging unit selector Пкр-1 is set to the СРД-5 or СРД-5МК (КВАНТ) position, the polarity of the reference voltage in the range receiving branch changes over.

Selector Пкр-2 ensures voltage polarity change at the input of $РЭ_{1-2}$, thus maintaining the direction of the follow-up. The position of selector Пкр-2 should correspond to the position of selector Пкр-1.

When the sight operates in conjunction with the СРД-5 or СРД-5МК (КВАНТ) radar range finders, the initial voltage at Д = 200 m. is ensured by connecting resistors R_{95} and R_{96} to $П_{11}$ circuit.

Resistors R_{91}, R_{92}, R_{93}, and R_{97} set the required gradient of the voltage, the middle portion of the bridge comprised of resistors $П_{11}$, R_{098}, R_{98} having required rated voltage.

Designations in Fig.34 mean:

$П_{11}$ – receiving potentiometer;

R_{91} to R_{97}, R_{99} – fixed resistors;

R_{093} – resistor for matching the sight input and the radar ranging unit output;

R_{98} – adjusting resistor;

$РЭ_{1-2}$ – electron relay;

P_{8-1}, P_{8-2}, P_{8-3}, P_{8-4}, P_{8-5} – contacts of relay P_8 (lock-on relay);

Пкр-1, Пкр-2 – radar ranging unit type selectors.

The radar ranging unit is connected to the sight by means of the RADAR – OPTICS (РАДИО – ОПТИКА) switch mounted on the sight head bracket.

When the switch is set to RADAR (РАДИО), the radar ranging unit receives the high voltage. In this instance, neon lamp $Л_7$ on the sight head bracket goes on

to indicate the high voltage available in the radar ranging unit.

When the radar ranging unit has locked on the target, wire 170 of the sight connected to the lock-on circuit of the radar ranging unit receives the voltage of -27 V. The application of voltage is indicated by green warning lamp $Л_4$ (mounted on the sight head) which in this instance goes on and relay P_8 is energized.

The contacts of relay P_8 change the range bridge over for reception of the range supplied by the radar ranging unit. Contacts P_{8-3} send the voltage $U_Д$ proportional to the range to the target to electron relay $PЭ_{1-2}$. Then, contacts P_{8-5} apply reference voltage U_0 to the receiving branch of the bridge, the voltage coming from the radar ranging unit along wires 152 and 158.

If the range, the sight follows up, differs from the range measured by the radar ranging unit, the voltage across slider of potentiometer $П_{11}$ differs from voltage $U_Д$. Electron relay $PЭ_{1-2}$ receives the mismatch signal transmitted as a difference of the two voltages. By means of the polarized relay contacts, electron relay $PЭ_{1-2}$ energizes the appropriate winding of the reversible clutch 2PT-200 ($PT_Д$) whose axle shifts the brush of potentiometer $П_{11}$ till the voltage across this brush comes to equal the voltage delivered by the radar ranging unit. In this event, potentiometer $П_{11}$ yields the followed-up range corresponding to the range measured by the radar ranging unit. Potentiometer $П_{11}$ follows up all changes of the range.

Resistor R_{093} is connected in series with the winding of the electron relay. It improves the smoothness of the bridge operation and increases the input resistance for the radar ranging unit.

Potentiometer $П_{11}$, resistors R_{97}, R_{98}, R_{098}, R_{99} are mounted in the computer; resistors R_{91} - R_{93}, R_{95}, R_{96}, selector Пкр, relays P_8 and r_{11} are arranged in the control box.

Electron relay $PЭ_{1-2}$, reversible clutch $PT_Д$, selector Пкр-2 and electric motor M_B are mounted in the computer. The electric motor used is of ДР-3.5М type, and relay P_8 of PC-13-10 type.

9. MANUAL INTRODUCTION OF RANGE

Receiving potentiometer $П_{11}$ changed over according to the Diagram in Fig.34 follows up the range introduced into the sight manually in the same way as in the case of automatic introduction.

When there is no voltage across relay P_8 (which happens when the radar ranging unit fails to lock on the target or when the sight is changed over to receive the range from the optical range finder), contacts P_{8-5} of relay P_8 change the range bridge circuit over for 27 V supply, contacts P_{8-3} connect relay $PЭ_{1-2}$ to the slider of transmitting potentiometer $П_{12}$ intended for manual introduction of the range, and contacts P_{8-4}, P_{8-1}, P_{8-2} short the circuit of resistors R_{91}, R_{92}, R_{93}.

The brush of potentiometer $П_{12}$ is linked up with the handle of the throttle control. The latter is turned to move the brush of potentiometer $П_{12}$ and to produce the mismatch signal (voltage difference between the brushes of potentiometers $П_{11}$ and $П_{12}$) sent to electron relay $PЭ_{1-2}$.

Electron relay $PЭ_{1-2}$ cuts in the appropriate winding of clutch 2PT-200 ($PT_Д$) via the contacts of the polarized relay. The axle of the electromagnetic reversible clutch moves the brush of potentiometer $П_{11}$ until the difference between the brushes of potentiometers $П_{11}$ and $П_{12}$ is nil.

The slider of transmitting potentiometer $П_{16}$ of the reticle circle bridge is rigidly connected with the slider of potentiometer $П_{11}$ and also turns in proportion with the range, changing the diameter of the reticle circle. Receiving potentiometer $П_{11}$ follows up the range correctly when the target is properly framed by the reticle circle. The pilot keeps the target framed rotating the handle of the throttle control.

When framing the target by the reticle circle, the circle diameter (in angular units) is determined by the formula:

$$d = \frac{B}{Д_0}\ 0.966 \qquad (27)$$

where:

B – base (target wingspan);

$Д_0$ – initial range to target;

0.966 – coefficient corresponding to aspect angle 1/4.

The sight has a device which computes "d" value using relation (27) and transmits it to the mechanism forming the reticle circle.

Relation (27) is solved by means of the electrical bridge shown in Fig.35. The bridge is supplied with stabilized 22 V.

$П_{16}$ – transmitting potentiometer introducing range $Д_0$;

$П_{14}$ – transmitting potentiometer introducing base B;

$П_{15}$ – receiving potentiometer following up the reticle circle diameter "d";

$\left.\begin{matrix} R160, \\ R_{201}, \\ R_{310}, \\ R_{311} \end{matrix}\right\}$ – fixed and adjusting resistors.

The bridge comprises a transmitting branch including potentiometers $П_{14}$ and $П_{16}$ and a receiving branch including potentiometer $П_{15}$ and resistor R_{310}. The resistance of potentiometer $П_{14}$ included into the bridge circuit is proportional to the target wingspan to be set. The total resistance of potentiometer $П_{16}$ and resistor R_{310} is proportional to the range introduced.

The reticle circle diameter is followed up by receiving potentiometer $П_{15}$, the angle of its brush turn being proportional to the diameter of the circle corresponding to the base set and to the range introduced. The adjusting resistor R_{311} ensures total resistance of potentiometer $П_{15}$ and resistor R_{311} proportional to the circle diameter. Adjusting resistor R_{160} matches the coefficients of resistances and voltages of the bridge branches.

If the reticle circle diameter does not meet the B and $Д_0$ values introduced, relay $PЭ_{2-1}$ passes the voltage to cut in one of the windings of electromagnetic reversible clutch 2PT-200 (PTк). The clutch axle shifts the light tube of the range mechanism; in this event, the reticle circle diameter changes and the brush of receiving potentiometer $П_{15}$ turns proportionally to the circle diameter. The circle is followed up until the winding of relay $PЭ_{1-2}$ is de-energized, i.e. until the diameter of the circle meets values B and $Д_0$ introduced.

Turning the handle of the throttle control (the slider of potentiometer $П_{12}$) and keeping the target framed by the reticle circle, the pilot introduces the range into the sight.

Resistor R_{201} and potentiometer $П_{14}$ form the transmitting branch of the bridge when following up the circle in position FIXED (НЕПОД.). The circle is changed by potentiometer $П_{14}$. This branch is connected by contact P_{9-5}, with the gyro caged.

Potentiometers $П_{14}$ and $П_{15}$, resistors R_{311} and R_{160} are mounted in the sight head; potentiometer $П_{16}$ is mounted in the computer; electron relay $PЭ_{2-1}$ - in the relay with the base plate; resistor R_{201} - in the control box; electromagnetic reversible clutch PTк - in the sight head.

The clutch is actuated by the electric motor MД, type ДГ-6, arranged in the sight head.

10. RANGE INDICATION CIRCUIT

The bracket of the sight head mounts an indicator of range $Д_0$ (voltmeter of M-63 type) showing the pilot the range to the target introduced by the radar ranging unit or manually by the range handle on the throttle control.

The voltmeter scale is graduated in hundreds of metres from 0 to 2000 m.

Fed from the slider of potentiometer $П_{17}$ to the voltmeter is voltage proportional to the range. The slider of this potentiometer moves simultaneously with the slider of the range bridge receiving potentiometer $П_{11}$.

Resistor r_{16} connected in series with potentiometer Π_{17} is intended for creating on the slider of potentiometer Π_{17} the voltages proportional to the ranges the computer follows up. Potentiometer Π_{17} and resistor r_{16} are arranged in the sight computer.

Resistor r_{19} mounted in the voltmeter housing is intended to ensure the operation of the voltmeter within 0 - 22 V measurement range.

11. INDICATED TIME FOLLOW-UP SYSTEM

Sight АСП-5НД employs the same formula of time T for all types of rockets and shells:

$$T = A + \varphi\,(Д_0)\cdot f(H)$$

where:

$\varphi\,(Д_0)$ - function of initial range;
$f\,(H)$ - function of height;
A - coefficient;
T - indicated time computed by the sight of design in question - function of time T_p.

Coefficient A and values $\varphi\,(Д_0)$ and $f(H)$ are different for every shell/rocket.

Refer to Section 2 of Chapter 3 of the present Manual for formulas of time T for different rockets and shells. The ballistic bridge is intended for determining T by formula (26).

To simplify the electrical circuit computing the expression for time T, the functions of the range and height are expressed for cannon by linear relations dependent upon mean functions $\varphi_{cp}(Д_0)$ and $f_{cp}(H)$. Due to this simplification the electrical bridge may be provided with common potentiometers for these cannon to introduce functions $\varphi_{cp}\,(Д_0)$ and $f_{cp}(H)$, the change-over to the linear functions $\varphi\,(Д_0)$ and $f(H)$ dependent upon them being done by means of change-over resistors. Rockets require special mean functions $f_{cp}(H)$ and $\varphi_{cp}\,(Д_0)$ and common potentiometers introducing them. The required functions of every

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shell/rocket are changed by means of change-over resistors, arranged in the ballistic unit.

Described below is the circuit of the time follow-up ballistical bridge (Fig.36).

The ballistical bridge circuit has two channels to follow up time T: one channel - for cannon, the other channel - for rocket launchers. The channels are changed over by operating contacts P_{2-4}, P_{3-5}, P_{3-2}, P_{3-1}, P_{2-6}, P_{2-5}, P_{3-6}, belonging to relays P_2 and P_3, which are cut in by the sight function switches.

See, how time T is followed up for rocket launchers. It is evident that relay P_3 should be energized to actuate the appropriate circuits. The bridge in question is comprised of several branches. The transmitting branch (branch of the range) includes transmitting potentiometer Π_5 connected according to the resistor diagram. Its slider is mechanically connected to potentiometer Π_{11} following up the range. The slider of potentiometer Π_5 moves proportionally to range $Д_0$. Functional potentiometer Π_5 computes $\varphi_{cp}(Д_0)$ for rockets, change-over to $\varphi(Д_0)$ for projectiles being done by connecting the proper ballistic resistor into the voltage divider circuit.

The voltage divider branch includes changeable resistors R_{33} and R_{26}. The bridge diagonal (branch of altitude) comprises transmitting potentiometer Π_3 whose slider moves in proportion with the flight altitude. Functional potentiometer Π_3 computes $f_{cp}(H)$ for rockets, change-over to $f(H)$ for each projectile being done by connecting changeable ballistic resistors to the circuit of potentiometer Π_3.

The receiving branch of the bridge is made up of receiving potentiometer Π_1 whose slider moves in proportion with time T. Coefficient Λ for various types of projectiles is computed by using changeable resistors in the circuit of potentiometer Π_1.

Thus, the slider of potentiometer Π_5 moves proportionally to range $Д_0$ and the slider of potentiometer Π_3 - propor-

tionally to altitude H. The slider of potentiometer Π_3 moves to change the value and direction of the current in the bridge diagonal (branch of altitude) proportionally to function $\varphi(Д_0)$. At the same time, the slider of potentiometer Π_3 yields voltage U_3 which is a product of the current flowing along the bridge diagonal multiplied by the resistance between the slider of potentiometer Π_3 and the voltage divider which is proportional to function f(H).

Hence, voltage U_3 amounts to:

$$U_3 = C \cdot \varphi(Д_0) \cdot f(H)$$

Potentiometer Π_1 is a follow-up potentiometer of the ballistic bridge. Its slider moves proportionally to T, and voltage U_1 across the slider changes proportionally to value T – A:

$$U_1 = C\ (T - A).$$

The wires running from the sliders of potentiometers Π_1 and Π_3 are connected to the input of the electron relay $PЭ_{1-1}$. If the indicated time differs from values $Д_0$ and H introduced, voltage U_1 is not equal to voltage U_3. The voltage difference is sent to the electron relay $PЭ_{1-1}$, which functions to close one of the windings of the reversible clutch 2PT-200 (PT_T), whose axle is mechanically linked with the slider of potentiometer Π_1. The slider of potentiometer Π_1 turns until $U_1 = U_3$ covering angle proportional to time T. The axle of the slider of potentiometer Π_1 carries the sliders of the time transmitting potentiometers, Π_7 being potentiometer of the prediction circuit, Π_8 and Π_9 – those of the circuit computing additional angles.

Sight АСП-5НД employs two potentiometers for introducing $\varphi(Д_0)$ relations: potentiometer Π_4 serving for cannon, and potentiometer Π_5 – for rocket launchers. Their sliders are mechanically linked with slider Π_{11} following up the range, and move proportionally to the range.

Function f(H) is also reproduced by two potentiometers Π_2 and Π_3 whose sliders are moving proportionally to the flight altitude.

For cannon, time T is followed up in the same way. As sight АСП-5НД is designed to be used with one cannon, type НР-30, the ballistic resistors of the circuits, which follow up time T for cannon, are arranged just in the control box.

Resistors connected to the circuit of potentiometers $П_2$ or $П_3$ from the side of the voltage divider are proportional to the minimum value of the altitude function for every ballistic characteristic. Resistors connected from the side of potentiometers $П_4, П_5$ maintain the rated resistance of the bridge diagonal required for matching the resistance and voltage characteristics in the bridge.

Adjusting resistors $R_{17} - R_{19}$, $R_{27} - R_{29}$, R_{37H}, R_{37P}, R_{39P}, $R_7 - R_9$ are intended to obtain the rated resistances of the circuit components required.

Resistors R_6, R_{36}, R_{16}, R_{26} are fixed ones.

Potentiometers $П_4$ and $П_5$ and resistors R_{37H}, R_{39H}, R_{37p}, R_{39p} are located in the computer, potentiometers $П_4$ and $П_5$ being arranged in the range unit.

Potentiometers $П_2$ and $П_3$ and resistors $R_{17} - R_{19}$, R_{176}, R_{175}, $R_{27} - R_{29}$, are placed in the altitude unit, and potentiometers $П_1$ and resistors $R_7 - R_9$ in the computer.

Resistors R_2, R_{12}, R_{22}, R_{32}, R_{16}, R_{26}, R_{36} are incorporated in the control box.

12. INTRODUCTION OF ATTACK AND SLIP ANGLES

Angles of attack and slip angles are introduced into the sight by special transmitter ДУАС.

In flight the ДУАС vanes are set in line with the airstream, i.e. in line with the fighter velocity vector. The vanes are mechanically connected with the sliders of the potentiometers mounted in the ДУАС housing: vertical vanes are linked with transmitting potentiometer $П_{21}$ of slip angles (Fig.127), horizontal vanes - with transmitting potentiometer $П_{20}$ of angles of attack. The angles through which the vanes turn in relation to the aircraft axes, are fed into the sight by the potentiometers burshes in the form of voltages proportional to these angles.

Sight АСП-5НД may operate in conjunction with ДУАС-133-8 and ДУАС-8м transmitters which are capable of measuring the attack and slip angles within the following limits:

$$-5^{\circ} \geq \alpha \leq +15^{\circ}$$

$$-4.5^{\circ} \geq \beta \leq +4.5^{\circ}$$

13. CONSTRUCTION OF AIRCRAFT SLIP CORRECTIONS

Sight АСП-5НД computes correction for aircraft slipping only when firing rockets. The correction is constructed by two components: horizontal component (in the wing plane) and vertical component (in the plane of aircraft symmetry).

The relationship between the components of the aircraft slipping correction is as follows: $\beta_a = A \cdot \alpha$; $\beta_c = A \cdot \beta$, where α – angle of attack; β – slip angle in the wing plane.

A. Construction of Aircraft Slip Correction

Horizontal Component

The horizontal component of the aircraft slip correction is computed in the sight by means of the zero gyro and in the same way as the vertical component of the elevation angle. The horizontal poles of the zero gyro magnetic correction unit are furnished with special coils $K_{НГС}$ whose key diagram is shown in Fig.37. These coils are fed by the computing system with the current proportional to some apparent angular speed of slipping:

$$\omega_{\beta} = A_{cp} \frac{\beta}{T_p}$$

Coils $K_{НГС}$ being energized, a correction current, proportional to ω_{β} is induced in the correction coils of the zero gyro. This current is transformed by the horizontal additional coils of the main gyro into the ampere-turns of the aircraft slip correction horizontal component causing the deflection of the gyro and line of sight in the horizontal plane through angle β_c. Slip angle β is introduced into the circuit by potentiometer $П_{21}$ arranged

in the transmitter. Time T_p is introduced into the circuit by potentiometer $П_{26}$ mechanically linked with time follow-up potentiometer $П_1$.

When angle β_0 is computed at time $T_p < 1.5$ sec., errors may arise (angle β_0 is less than the rated angle, and the error increases with decrease of time). Actually the errors are not high, as, when firing rockets, time T_p can not be less 1.5 sec.

The allowance for A_{op} is made by changeable resistors mounted in the ballistic units. The computing circuit is energized via contacts P_{9-1}, P_{2-3}, and P_{3-3}, which allows it to cut off the circuit of the aircraft slip correction horizontal component, with the sight in the FIXED (НЕПОД.) position, when firing cannons and during bombing. Adjusting resistor R_{216} is arranged in the zero gyro unit.

B. Construction of Aircraft Slip Correction

Vertical Component

The vertical component of the aircraft slip correction is computed by the sight through turning the plano-parallel plate (ППП), which is included into the sight optical system and provided with a system of automatic follow-up of the required angles in the vertical plane. β_a is constructed together with the constant portion of the elevation angle vertical component by the formula: $\phi_{ов} = A_{op}\,\alpha + B'$

where B' – constant portion of the elevation angle vertical component.

In sight АСП-5НД the vertical component of the aircraft slip correction is computed by two ways:

(1) by introducing the value of the angle of attack from the B transmitter;

(2) by introducing the value of the angle of attack from the altitude unit as a function of altitude H, average speed at a given altitude $V_{cp.H}$, and average value of overload at a given altitude

The key electrical diagram for computing the vertical component of the aircraft slip correction is given in Fig.38.

When firing rockets, with the sight operating in conjunction with the ДУАС transmitter, transmitting potentiometer $П_{20}$ of the angles of attack is connected to the transmitting branch of the potentiometric bridge. ϕ_{OB} is followed up by potentiometer $П_{18}$, kinematically connected with the plano-parallel plate which receives through electromagnetic clutch P-200 the pulse from the mismatching amplifier of $РЭ_{2-2}$ (electron relay) connected to the diagonal of the potentiometric bridge. The allowance for coefficient A_{op} for various projectiles is made by changeable ballistic resistors, connected to the circuit of potentiometer $П_{18}$ and arranged in the ballistic units.

Connected to the ДУАС - SIGHT (ДУАС - ПРИЦЕЛ) circuit between transmitting potentiometer $П_{20}$ and receiving potentiometer $П_{18}$ is an electrical filter (damper) presented by link RC. The filter is intended to smooth the reticle sharp fluctuations and in this way to facilitate sighting. In this instance the follow-up of angle ϕ_B is slowed down by the value of filter time constant $\tau = 4.8$ sec.

The filter consists of capacitors C_{17}, C_{18}, type ЭТО, resistors R_{206}, R_{212}, type МЛТ, and adjusting resistor R_{0205}, type СП. All these elements are arranged in the control box.

When function switch Н-ДУАС is set to the Н position, altitude unit potentiometer $П_{19}$ becomes a transmitting branch of the potentiometric bridge. The centre point of potentiometer $П_{19}$ yields voltage as a function of altitude, fighter average speed and average overload at a given altitude.

When the altitude changes, the sight continuously follows up the vertical component of the aircraft slip correction. The allowance for various functions of $f(V_{OPH}; \theta_H)$ for different types of aircraft is made by resistors R_{208}, R_{209}, R_{210}, R_{211}, R_{10}, R_{010}, arranged in the control box and changed over by means of selector Пкр-3.

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When firing rockets at ground targets, the voltage divider of resistors R_{152} and R_{154} becomes a transmitting branch of the potentiometric bridge. The voltage divider is connected by a jumper mounted in the ballistic unit (wires 99a and 099a are connected).

When the sight is changed over to fire cannon, contacts P_{3-4} energise the voltage divider, whose resistors R_{54} and R_{52} yield voltage corresponding to $\phi_{os} = 0°$ and contacts P_{2-1} and P_{2-2} connect additional resistors R_{40} and R_{50} to potentiometer $П_{18}$. The plano-parallel plate (ППП) returns to the zero position. Thus, when firing cannon, the vertical component of the aircraft slip correction is not computed.

The sensitivity of the masmatching amplifier is adjusted when the sight operates in conjunction with ДУАС transmitter, whose $П_{20}$ potentiometer circuit includes an electrical filter, comprising some resistors.

When the ДУАС transmitter is switched off, the filter is de-energized and the mismatching amplifier sensitivity increases. To prevent the plano-parallel plate against auto-vibrations, the circuit includes ballast resistors R_{204}, R_{206}, R_{207} of МЛТ type, which decrease the sensitivity of the follow-up system. The potentiometric bridge, which follows up the vertical component of the aircraft slip correction is energized through contacts P_{2-3} and P_{3-3}. When the sight operates in the bombing mode of operation, relays P_2 and P_3 are de-energized and the circuit, which feeds voltage to the bridge, is off. In so doing, the plano-parallel plate may be manually set to the given angle.

Resistors R_{40}, R_{50}, R_{38}, R_{207}, R_{212}, R_{205}, R_{152}, R_{154}, R_{54}, capacitors C_{17}, C_{18}, tuned resistors R_{52}, R_{20}, R_{101}, R_{66}, R_{0205}, R_{58}, R_{55} are arranged in the control box.

Potentiometer $П_{18}$ of ПП-400 type is mounted in the sight head. Resistor R_{206} is incorporated in the sight head bracket.

The plano-parallel plate is operated by the electromagnetic clutch, type P-200.

This clutch is not provided with the tachogenerator, otherwise the construction being similar to that of electromagnetic clutch 2PT-200. Clutch P-200 is arranged in the sight head.

Adjusting resistors R_{64}, R_{61}, R_{59}, R_{65} and fixed resistors R_{62}, R_{68}, R_{60} of the Π_{19} potentiometer circuit are accommodated in the altitude unit.

14. INTRODUCTION OF BALLISTIC CHARACTERISTICS OF EMPLOYED WEAPON

The values of the angular corrections (lead, elevation and slip corrections) depend on the ballistic characteristics of the weapon for which these values are computed.

Sight АСП-5НД takes allowance for the weapon ballistic characteristics by setting in the computing circuits changeable resistors, whose value varies in accordance with the type of the weapon employed.

The changeable resistors, which are included into different circuits of the sight computing system to ensure the operation of these circuits for certain types of rockets, comprise a changeable ballistic unit. It is evident that the number of such ballistic units should correspond to the number of rocket types.

Fig. 39 represents the electric circuit of the ballistical units for the rockets, the sight was designed to operate with. Resistors, included into the computing circuits for cannon (type HP-30), are fixed and arranged in the control box.

15. SETTING OF SIGHT OPERATION MODES

Sight operation modes are changed over by selectors accommodated on the sight head bracket.

1. Selector Пкс has positions HP-30-PC and provides for changing over the sight operation modes to fire cannon or rockets. The allowance for the type of rocket is made by setting the proper changeable ballistic unit into the control box.

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The sight computing circuits are changed over for firing shells or rockets by relay contacts P_2 and P_3. The relays are energized by 27 V D.C. and are switched by selectors Пкс and Пкр.

Relays P_2, P_3 are of PC-13-10 type. They are arranged in the control box.

2. Selector Пкр has positions С – Б and provides for the sight operation in the mode of firing or bombing. In the bombing mode of operation selector Пкр disconnects the minus circuit of the P-200 clutch windings to exclude the opportunity of the plano-parallel plate operation from the signal of the zero drift currents induced in the mismatching amplifier.

Selectors Пкс and Пкр energize wires 501p, 546, 542, 541, running to the aircraft fire control system.

3. Selector Пкв is intended to change over the circuits, which compute the vertical component of the aircraft slip correction, for operation from the ДУАС transmitter or from the altitude unit. The main mode of sight operation is in conjunction with the ДУАС transmitter. The method of computing the vertical component of the aircraft slip correction from the altitude unit is used only in case of ДУАС failure. In this case selector Н-ДУАС should be set to the Н position.

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Chapter V

DESCRIPTION OF SIGHT KEY DIAGRAM

A key diagram of the sight is shown in Fig.127.

The sight uses 27 V D.C. from the aircraft mains through the interference filter, and 115 V, 400 c.p.s. from the special generator.

The sight heater and the illumination lamp are connected to wires 01-02 and controlled by switch $ВКП_1$ (heater).

Switch $ВКП_1$ applies +27 V to switch $ВКП_2$. The contacts of switch $ВКП_2$ (sight) deliver +27 V and 115 V, 400 c.p.s. to the other circuits of the sight.

Computing circuits of the sight (circuits of the lead and elevation, ballistic bridge, reticle circle follow-up circuit) are connected to wires 3 - 4 and fed with stabilized voltage (22 V) coming from the voltage regulator CH-4. Wires 2, 02, 002 of the circuit are grounded to the sight housing.

Wires 125, 129, 130, 131, 152, 158, 166, 166a, 170, 295, 296, 317, 351 are screened, the screens being connected to the sight housing.

Switches $ВКП_1$ and $ВКП_2$, damping button КНД, ДУАС and throttle control handle refer to the aircraft equipment.

1. ILLUMINATION AND WARNING LAMPS

Lamp $Л_1$ (27 V, 18 W) is intended to illuminate the sight reticle (pip and circle): it is connected to the mains through illumination rheostat $R_Л$. The latter regulates the intensity of illumination of the circle and pip of the sight reticle. All members of the circuit in question are accommodated in the rear cover of the sight head.

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Lamp $Л_3$ (red) is intended to indicate the time of coming out from attack.

Lamp $Л_4$ (green) indicates that the radar ranging unit has looked on the target. The minus conductor of lamp $Л_4$ receives the voltage from the radar ranging unit.

Lamps $Л_3$ and $Л_4$ are mounted in the sight head housing.

2. SIGHT HEATERS

The sight head and the zero gyro are provided with heaters intended to eliminate temperature errors and to create normal conditions for operation of the sight components.

The sight heaters are cut in by means of switch $ВКП_1$ (heater).

A. Sight Head Heater

Heaters O_8, O_9, O_{10} maintain the constant temperature in the gyro head housing which is necessary for keeping resistances of the coils (copper) and diamagnetic materials (aluminium) characteristics constant.

Heater O_{11} is wound over main coil K_y placed in the pole of the gyro cover, heater O_{10} over the coil attached to the gyro housing bottom, heater O_8 over the brass former of coil K_{y2}, and heater O_9 over coils K_{y2} and K_{y3}.

These heaters are switched on by contacts of relay P_{11}, the coil of relay P_{11} being connected to the circuit by the thermoregulator T_4 adjusted for the cut-off temperature of $+60^o \pm 2^oC$.

Relay P_{11} is the relay of the АСП-4Н sight heater. Capacitor Cu_4 and resistor ru_4 are connected in parallel with the thermoregulator T_4 for quenching the sparks.

Relay P_{11}, thermoregulator T_4, capacitor Cu_4 and resistor ru_4 are mounted on the front cover of the sight head.

Heaters O_{12}, and O_{13} are intended to protect the semi-silvered mirror and the objective lens of the sight head against fogging.

The objective heater O_{12} is a transparent current-conducting film applied to the objective inner surface. Heater O_{13} is a circular current-conducting film applied to the mirror surface facing the mounting.

B. Zero Gyro Heater

The heater of the zero gyro includes a number of heating elements arranged in and out of the gyroscope housing (in the heat-insulated jacket). The heaters are controlled by means of two thermoregulators, one being arranged in the gyroscope housing, and the other - in the jacket.

Heaters 0_1 and 0_2 accommodated inside the gyro housing are bifilar windings wound over the former of the main coil of the gyro. The heaters are controlled by relay P_{12} of thermoregulator T_1. The heaters are disconnected under +70°C ±2°C.

On the outside, the gyroscope is heated by heaters 0_4, 0_5, 0_6, 0_7 controlled by relay P_{17}. Heaters $0_4 - 0_7$ are mounted on the gyroscope housing.

Thermoregulator T_2 arranged inside the heat-insulated jacket controls relay P_{17}, disconnecting the heater under +30°C ±2°C.

Relays P_{12} and P_{17} are the heater relays of sight АСП-4Н. Spark-quenching capacitors Cu_1, Cu_2 and resistors ru_1, ru_2 are connected in parallel with the thermoregulators

3. LOCK SWITCH

Lock switch Кsap, mounted on the sight head, locks the gyro to break the circuit of the coil of relay P_9 and to cut out electric motors $M_Г$ and $M_В$ of the gyro and of the computer.

Unlocked (operating) position of the gyro requires that the circuits of the coil of relay P_9 and of electric motors $M_Г$ and $M_В$ be closed (the lock lever is in GYRO - (ГИРО) position).

4. ELECTROMAGNETIC LIMITER CIRCUIT

When the gyro has deflected through an angle approximating that at which the gyro reaches the mechanical limiter, the spring contact $КН_{90}$ on the gyro frame touches the plate secured to the sight head housing. The sight head body receives the minus of the mains, therefore relay P_{90} is energized the moment the contact touches the plate. In

this instance, the contacts of relay P_{30} and resistor r_3 in the circuit of the gyro main coil pass additional current, the magnetic flux in the main coil increases and the deflection angle of the gyro spin axis decreases. The circuit of the electromagnetic limiter breaks. If later on the deflection angle of the gyro spin axis exceeds the maximum value (13^o), the above process is repeated, and the sight reticle forms an oscillating pattern during operation.

Relay P_{30} used is of РП-7 type. Capacitor C_3 is intended to smooth the current pulses sent to relay P'_{30} when the spring contact touches bus $КН_{30}$. Relay P_{30} and capacitor C_3 are mounted in the control box.

5. DAMPING CIRCUIT

During sharp turns, the electromagnetic limiter may fail to eliminate blurring of the reticle. In such cases the damping button will be pressed.

When the button is depressed, relay P_{15} operates to close contacts P_{5-1}. Resistor r_7 and the prediction coil pass an additional current, the magnetic flux increases and the deflection angle of the gyro spin axis sharply decreases.

6. ELECTRIC MOTORS OF SIGHT HEAD AND ZERO GYRO

Sight head gyro electric motor $М_Г$, type ДГ-4М and electric motor $М_Д$, type ДГ-6, of the reticle circle and plano-parallel plate mechanism follow-up, are controlled by switch $ВКП_2$ SIGHT (ПРИЦЕЛ) which delivers 27 V D.C. to them.

Gyro electric motor $М_Г$ receives voltage by means of lock switch КВар (with the gyro locked, the circuit of the electric motor $М_Г$ is open).

The radio interferences caused by operating electric motors $М_Г$ and $М_Д$ are reduced by shields that screen the supply cables and by duct capacitor, type КБП-0.025µF used as filters.

The zero gyro electric motor $М_{НГ}$ is an induction motor with shorted rotor. Capacitor C_4 and resistor r_4 are intended to shift the phases in the rotor windings. The

electric motor is cut in by contacts P_{9-4} and P_{9-6}, with the gyro unlocked.

7. PURPOSE OF CONTACTS OF SIGHT OPERATION MODES CHANGE-OVER RELAYS

Relays P_2, P_3 control the circuit operation in firing. The contacts of relay P_2, P_3 serve the following purposes:

P_{2-1}, P_{2-2} – change over ballistic resistors in the receiving branch of the bridge, which follows up the vertical component of the aircraft slip correction, to follow up the angle by the plano-parallel plate, when the operational mode selector is set to the PC position, and to drive the plano-parallel plate back to the zero position, when the mode selector is set to the HP-30 position.

P_{2-3}, P_{3-3} – normally opened – energize the bridge following up the vertical component of the aircraft slip correction.

P_{2-3} – normally closed – de-energize the circuit following up the aircraft slip correction horizontal component, when the mode selector is set to the HP-30 position.

P_{3-6}, P_{2-5} – normally closed – change over the electrical P_{2-4}, P_{3-5} circuits of the ballistic bridge to follow up P_{3-2}, P_{2-6} time T for cannon or rocket launchers. P_{3-1}

P_{3-6}, P_{2-5} – normally opened – change over resistors in the circuit of $K_{НГП}$ sighting coils with respect to the type of the weapon employed (cannon or launcher).

P_{3-4} – with the operation mode selector in the PC position, energize the circuit computing aircraft slip correction vertical component; with the selector in the HP-30 position, disconnect the circuit mentioned above and connect the transmitting branch of the bridge to

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the middle point of the constant voltage divider. As a result, the plano-parallel plate takes the zero position.

Bombing with the employment of sight АСП-5НД should be performed with the locked sight head gyro. To ensure automatic operation of the sight in firing, unlock the main gyro by setting the lock lever on the sight head to the GYRO position. In so doing, relay P_9 operates whose contacts connect the following circuits:

P_{9-1} - with the gyro in the FIXED (НЕПОД.) position, de-energize the circuit following up the aircraft slip correction horizontal component.

P_{9-4}, P_{9-6} - feed alternating voltage to the zero gyro.

P_{9-5} - connect the transmitting branch of the reticle circle bridge with the base and range potentiometers-at GYRO (ГИРО); connect the transmitting branch with the base potentiometer and resistor R_{201} - at FIXED (НЕПОД.) position.

P_{9-2} - energize the sight computing circuits with 22 V stabilized voltage.

When the target is locked on by the radar range finder, relay P_8 operates whose contacts make the following switchings:

P_{8-5} - change over the receiving branch of the range follow-up bridge to 27 V voltage or to the reference voltage from the range finder.

P_{8-3} - change over the range follow-up circuit to the range voltage from the radar range finder or from the range manual introduction potentiometer.

P_{8-1}, P_{8-2}, P_{8-4} - short resistors R_{92}, R_{91}, R_{93} when sight is functioning in the OPTICAL (ОПТИКА) mode of operation.

8. OPERATION OF SIGHT WHEN FIRING SHELLS AND ROCKETS

When firing shells and rockets, the sight should perform the following tasks:

(1) compute in the sight field of vision the necessary angular corrections for prediction, sighting and slip of the aircraft;

(2) follow up the range to the target, flight altitude and rated indicated time of the shell/rocket flight necessary for computing the angular corrections specified above;

(3) send necessary signals about the mode of the sight operation and the operating conditions. During firing, the sight is controlled by relays P_2, P_3, P_8, P_9 and switches $ВКП_1$, $ВКП_2$, $ПК_в$, $КК_{р-1}$, $ПК_{р-2}$, $ПК_{в.с}$, $ПК_{р-3}$, Пкр, Пко.

To prepare the sight for operation, proceed as follows:

1. Mount into the control box a changeable ballistic unit corresponding to the type of the employed rocket.

2. Set switches $ПК_{р-1}$ and $ПК_{р-2}$ to the positions corresponding to the radar range finder mounted on the aircraft.

3. Set switch Пкв to the ДУАС position corresponding to the main way of computing the aircraft slip angle vertical component.

4. 3 - 14 min. prior to take-off (depending on the ambient temperature) cut in switches $ВКП_1$, and $ВКП_2$. In so doing the following circuits are energized: sight head and zero gyro heater, reticle circle illumination lamp, filament circuits of valves of the CH-4 voltage regulator, zero gyro amplifier and electron relays; sight head electric motor $M_Д$ and altitude unit electric motor M_H.

5. For sighting, unlock the sight head gyro (close contacts КВар) after the take-off to start the electric motor $M_Г$ of the sight head gyro (the sight reticle moves), electric motor $M_В$ of the computer, and relay P_9, whose contacts energize the computing circuits.

6. Set switches Пко-Пкр to position corresponding to the type of the weapon fired. In this instance, the voltage is fed to one of the ballistic change-over relays P_2

or P_3. The contacts of these relays change over the ballistic bridge resistor groups and the sighting circuits, adjusting the circuits for computing the angular corrections for appropriate weapons. When rockets are fired with the switch ПКС set to PC, relay P_3 operates connecting by its contacts the follow-up system of the aircraft slip corrections.

The ДУАС transmitter introduces into the sight the values of the fighter attack and slip angles. The sight reticle moves down through the angle produced by the vertical component of the angle of attack correction and by the constant component of the elevation angle (corresponding to the type of rocket).

When cannon are fired and switch ПКС is set to the НР-30 position, the computing circuit of the horizontal component of the aircraft slip correction is disconnected, while the vertical component bridge is connected to the middle point of the voltage divider. The divider yields voltage corresponding to the ZERO position of the plano-parallel plate (ППП). The follow-up system returns the plano-parallel plate to the ZERO position with the help of electromagnetic clutch P-200.

7. In case the sight functions together with the radar ranging unit, set switch $ПК_{ВС}$ to RADAR (РАДИО) thus feeding the high voltage to the radar ranging unit. In 1 - 3 minutes lamp $Л_7$ must go on indicating that the high voltage is available in the radar ranging unit circuit.

Before the radar ranging unit has locked on the target, the sight operates receiving data from the outer-base range finder. The diameter of the reticle circle and the mobility of the reticle depend on the range introduced by the range manual introduction potentiometer $П_{12}$ and on the base set on the base scale by turning the brush of potentiometer $П_{14}$. When the target comes within the radar ranging unit operation range, green indicating lamp $Л_4$ LOCK-ON (ЗАХВАТ) goes on and relay P_8 is energized. The contacts of relay P_8 disconnect the range manual introduction circuit and change the sight over for reception and follow-up of

the range (transmitted by the radar ranging unit) by potentiometer Π_{11}.

The slider of potentiometer Π_{17} sends to the voltmeter a voltage proportional to the range to the target. The slider of this potentiometer moves together with the slider of the follow-up potentiometer Π_{11} of the range bridge.

The sliders of potentiometers Π_4 (when firing the cannon) or Π_5 (when firing the rocket weapons) connected according to the resistor diagram and arranged on the common axle with the slider of potentiometer Π_{11} feed the current (proportional to the range) to the diagonal of the ballistic bridge. The resistance of potentiometer Π_2 (when firing the cannon) or of potentiometer Π_3 (when firing the rocket weapons) is adjusted in proportion with the altitude.

The indicated time of the shell/rocket flight is followed up on ballistic bridge potentiometer Π_1.

The slider of potentiometer Π_7 fixed on the same axle with the slider of potentiometer Π_1 feeds the current whose intensity depends upon the changed indicated time of the shell/rocket flight, to the circuit of sight head gyro main coils K_{y1} and K_{y2}.

Additional coils $K_{\text{КГ}}$ and $K_{\text{КВ}}$ of the sight head gyro connected to the circuit of the horizontal and vertical channels of the zero gyro correction, pass the current, proportional to the product of the aircraft angular speed in the horizontal plane (the sum of the aircraft angular speed and of the apparent speed proportional to factor a' in the vertical plane) and the indicated time taken off the sliders of potentiometers Π_8 and Π_9 arranged on the same axle with the slider of potentiometer Π_1.

When the central pip of the reticle follows the target, the sight head gyro deflects through an angle proportional to the target relative angular speed. It interacts with the magnetic flux of the main and additional coils and deflects the reticle within the sight field of vision through the lead angle and the elevation angle in the horizontal plane (the lead angle and variable component of the elevation angle in the vertical plane).

When sighting, the pilot should keep the central pip of the sight reticle matched with the centre of the target. Before opening fire, 3 - 5 seconds must elapse, which is enough to match the movement of the sight reticle central pip and of the target.

When the sight head gyro computes the total angular correction exceeding 13°, spring contact $КН_{30}$ on the gyro mounting touches the busbar attached to the sight head housing.

The contact touches the busbar to feed voltage to the coil of relay P_{30}. The contacts of relay P_{30} cut resistor r_3 in the circuit of the gyro main coil to energize this circuit with 27 V. In this instance, the current in the main coil increases to decrease the angle of the gyro deflection. If the total angular correction keeps exceeding 13°, the sight reticle oscillates.

The sharp turn of the aircraft requires that the damping button $КН_Д$ be pressed to considerably decrease the angles of lead. This is achieved due to increase of the current in the prediction circuit caused by small resistor r_7 connected to it.

If no encounter with the enemy is anticipated in flight, the pilot must cut off switch КВар keeping the sight ready for operation as the valves of the voltage regulator, zero gyro amplifier and electron relay are energized and the heaters are on.

For turning the sight off, first lock the sight head gyro by bringing the locking lever of the sight head to FIXED (НЕПОД.). Then turn off the switch SIGHT (ПРИЦЕЛ) and the switch HEATER (ОБОГРЕВ).

Note: Never take off and land with the gyro unlocked (knob against GYRO (ГИРО)).

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Chapter VI

SIGHT DESIGN

The sight is comprised of separate units connected electrically, therefore every unit is described in this manual separately.

1. SIGHT HEAD

The sight head (Fig.41) is intended to form an image of the reticle in the sight field of view and to deflect this image through required angles.

The image may be formed as an unbroken circle of variable diameter with a central pip both at GYRO (ГИРО) and at FIXED (НЕПОД.) positions.

A detailed description of the formation of the reticle image in the sight head is contained in Sections A (Optical System) and B (Gear Train) of the present Paragraph.

A. Sight Head Optical System

The sight head is furnished with an optical system of the collimator type.

The optical system includes (Fig.42): diffusing glass light filter 7; reflecting prism 6; two-lens objective 8; gyro mirror 9; plano-parallel plate (semi-silvered mirror) 10; plano-parallel plate 11 with reflecting surface and small right-angle prism glued to plano-parallel plate 11; mirror cone 12; glass plate 4 with transparent pip; light tube 13; plano-convex condenser lenses 3 and 15; light source 2 (27 V, 18 W lamp, type CM-46); metal reflector 1; mirror 14.

Gyro mirror 9 placed at the point where the light rays converge, between objective 8 and its focal plane, serves to plot angular corrections both in the horizontal and vertical planes.

Lamp 2 sends the light rays through condenser lens 15, mirror 14 to light tube 13 whence they get through the circular groove to the reflecting portion of cone 12. The light tube is shifted along the mirror cone axis to change the diameter of the image of luminous ring located in the focal plane of objective 8.

The light tube is an elongated glass cylinder aluminium-coated all along its surface except for the end facing the illumination lamp. Made on the other end of the light tube is a circular groove that passes the light beam forming the luminous circle. Aluminium coating of the light tube is painted black. The end of the light tube with the circular groove is made spherical inside with a small lens and metal cap glued to it.

Other condenser lens 3 passes the light rays of lamp 2 to glass disc 4 with transparent pip arranged in the focal plane of objective 8. Then small prism 5 and plano-parallel plate 11 (with semi-translucent layer in the cemented optical block) direct the rays to the centre of the luminous ring.

Plano-parallel glass plate 11 is made of two parts glued together and chamfered at 45°. One part of the plate has a semi-transparent spot on the chamfer intended to project the luminous pip to the centre of the circle. The other half of the plate carries a small right-angle prism cemented to it.

Condenser lens 15 is made of yellow-stained glass to improve the contrast of the sight reticle circle image against brightly lit background. Therefore, the reticle is projected in the sight field of view bright yellow.

Thus, the images of luminous ring and pip pass through clear glass reflector plate 10 and reach gyro mirror 9 which reflects them to the reflecting surface of planc-parallel plate 10 and finally to objective 8. Emerging from the objective, the images pass to reflecting prism 6 and finally

reach the observer's eye. The observer sees the images of the luminous circle and the pip projected to infinity.

Light filter 7 made of diffusing gass may be placed in front of reflecting prism 6 for dimming the background against which the target appears.

The images of the central pip and of the luminous reticle circle designed for framing the target may change their position in space by changing the position of gyro mirror 9 and by turning plano-parallel plate (semi-silvered mirror) 10.

Extreme positions of the movable components of the optical system intended to shift the sight line are shown by dashes in Fig.42.

The maximum deflection angle of the gyro mirror (and the gyro axis) is 14°, that of the semi-translucent plate is $8^{\circ}30'$.

B. Sight Head Gear Train

A gear train of the sight head is shown in Fig.43.

Electric motor 27 (type ДГ-4М) is designed to rotate gyroscope 1. Rotation from the electric motor is transmitted to the gyroscope by means of spring belt 26. Another electric motor 2 (type ДГ-6) rotates the reticle circle follow-up mechanism and the tilting mechanism of plano-parallel plate 24. Electric motor 2 is coupled with the gears of electromagnetic reversible clutch 20 by means of two screw pairs and four spur gear pairs. From axle 16 of electromagnetic reversible clutch 20 motion is imparted to the brush of receiving potentiometer 22 ($П_{15}$) through the gear pair, screw pair 21, worm gear 15 and worm-and-wheel pair 23. Besides, motion is transmitted through screw pair 21 to motion screw 12 along which nut 14 bearing glass light tube 11 moves.

Electromagnetic reversible clutch 5 is driven by electric motor 2 through spur pair 3 and reduction unit 4.

Mounted on the axle of electromagnetic reversible clutch 5 is coupling 6. Motion is further transmitted through the spur gear pair and worm-and-wheel pair to friction clutch axle 10. From the friction clutch axle motion is imparted

to plano-parallel plate 24 through the spur gear pair. Friction clutch axle 10 is coupled through the spur gear with knob 8 and scale 9 of sighting beam angles deflected by mirror 24. Friction clutch axle 10 imparts motion through gear pair 25 to the brush of receiving potentiometer 7 ($П_{18}$).

Base setting knob 19 is mounted on the axle together with scale 18 and is connected with base setting potentiometer ($П_{14}$).

Locking lever 13 is coupled with the locking axle of gyroscope 1 by means of levers.

C. Sight Head Design

The sight head includes:

(1) housing with objective and reflector;
(2) front cover with gyro and two electric motors;
(3) semi-silvered mirror unit;
(4) rear cover with reticle circle unit;
(5) bracket with light filter.

General view of the sight head is shown in Fig.44.

Outside the sight head carries the following controls and indicators:

3 and 5 ($Л_4$ and $Л_3$) - signal lamps (LOCK ON - ЗАХВАТ) to the left, and COME OUT - ВЫХОД to the right);

7 - reticle illumination rheostat knob;

2 - base setting knob;

6 - mirror tilting knob;

1 - sight head gyro locking lever;

4 - receptacle for connecting the range indicator.

8 and 9 ($ШР_2$ and $ШР_1$) - connectors serving for connecting the sight head to the sight circuit.

(1) Housing with Objective and Reflector

The housing with the objective and reflector is a base carrying all other assemblies of the sight head. Housing 1 (Fig.41) is a cast box of aluminium alloy with front, rear and side hollow walls. The housing upper wall is provided with a threaded hole to receive the objective in the mounting.

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Objective 2 is placed in the threaded mounting and lock-pinned. To protect the objective from cracking when the temperature is changed, it is pressed with a spring adjusting ring and clamped with a threaded ring. The mounting with the objective screwed into the housing is fixed with lock screws after focusing.

The objective is protected against getting dim by a heater (a circular current-carrying film on the lower portion of the objective lens).

The current-carrying layer receives positive voltage via a spring contact secured to the plano-parallel plate and contacting the current-carrying busbar on the objective mounting. The busbar delivers the voltage to the current-carrying layer by means of a special contact insulated from the objective mounting. The other contact connected with the sight head body through the objective mounting feeds the negative voltage to the current-carrying layer.

The housing is furnished with two lugs with bearing surfaces which mount two brackets 3 for fixing reflector 4. Two slots made in the side surfaces of the reflector receive the lockpins when the reflector is mounted in the brackets. The reflector is locked with retaining strips, the screws being locked with wire. The housing lugs accommodate two indicating lamps, lamp 3 (Fig.44) going on when the radar ranging unit locks on the target, and lamp 5, when it is time to come out from attack.

Fixed to the left bottom portion of the housing are two bearings with shaft whose ends carry forked levers for operating the lock. The shaft is protected by a special jacket. The sight head is electrically connected with other sight units by a cable and connector ШР-2.

(2) Front Cover with Gyro Unit

Front cover 2 (Fig.45, 46) is a rectangular plate with gyro unit 3 and two electric motors 1 and 4 secured to it. The shaft of electric motor 4 designed for rotating the gyro is provided with pulley 5 and spring belt 6. Attached to

the front cover are roller 8 intended to guide and to tighten belt 6, and block 7 securing the wires running to the electric motors. Belt bending is precluded by washers placed under the roller.

Electric motor 1 actuates the mirror tilting mechanism and the reticle circle follow-up mechanism. Mounted on the same side where the electric motor and the gyro (Fig.46) are secured, are relay 9 (P_{11}) of the gyro heating system; angle bar 13 with one adjusting resistor 14 (R_{30}), two fixed resistors 12 (R_{030} and R_{77}) and nine-terminal block 15 for unsoldering the wires; resistor R_{139}; four duct capacitors 10 for suppressing the noises generated by electric motors 1 and 4; six-terminal block mounting three thermistors (RT_1, RT_2, RT_3).

The thermistors increase stability of angles computation at plus temperatures.

Front cover 2 is screwed to the sight head housing and protected by a jacket with heat-insulating lining glued to its inner side.

The main part of the front cover is the gyro unit (Fig.47).

The gyro incorporates: rotating mirror 3 with mounting 13 and spherical dome 6 secured on the axle. The axle is fixed in the gimbal so that it can rotate together with the latter in the ball bearing screwed to gyro cover 5. The cover is made of permalloy and is provided with a specially shaped pole which carries a part of gyro main coil Ky_1 and heater winding O_{11}. The gyro cover is screwed to gyro housing 8. The latter is made of permalloy forming a sleeve ending in cone.

Cores 11 mount four correction coils 10 (K_{KT} and K_{KB}), heater coil O_{10} being screwed to the flat portion of the housing bottom. Terminal block 11 is fixed to the outer flat surface of the housing bottom. It serves to connect the wires running from the inner coils of the gyro.

Four holes in the cone portion of the bottom of housing 8 accommodate four bushings 9 with flanges. The openings of the bushings receive four cores 11 which are locked by screws upon setting the core-to-dome air gap.

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The other part of main coil K_{y2} and negative coil K_{y3} wound over brass former 12 are fitted inside the cylindrical portion of the gyro housing. Two windings O_8 and O_9 (inner and outer) of the heating system are wound over the same brass former that is screwed to the gyro housing. Thermoregulator 7 is secured to the guiding slots inside the former. The external view of the thermoregulator is shown in Fig.48. The thermoregulator includes bimetallic plate 3 attached to bracket 1. The latter carries adjusting screw 2 with contact, current-carrying wires being soldered to plates 4.

The gyro lock design is as follows. Hinged four-bar mechanism 1 is fixed to ring 4 (Fig.47) screwed on gyro cover 5. The mechanism carries lever 2 with three stops secured to it for locking the gyro mirror. Axle 14 of the four-bar mechanism is connected to locking lever 13 (Fig.43). The locking lever rotates to turn axle 14 (Fig.47) which shifts the four-bar mechanism. The stops of moving lever 2 lock the mirror.

The gyro unit is electrically connected with the sight set by a cable and connector ШР-1.

(3) Plano-Parallel Plate Unit

The unit (Figs 49, 50, 51) incorporates parts of the tilting mechanism and reticle circle follow-up mechanism. The parts of the unit are fixed to П - shaped cast housing 11. Mounting 4 (Fig.50) of the plano-parallel plate is secured to housing 11 on axle shafts with ball bearings. The plate is fastened to the mounting by means of four angle bars 4 with rubber paddings (Fig.49).

The plate is protected against dimming by a circular current-carrying film applied to the mirror non-operating surface. The current-carrying film receives current from contacts 5 (Fig.50).

Plano-parallel plate mounting 4 is provided with weight 14 (Fig.49) serving for balancing the plate. The plate mounting carries sector 3 (Fig.50) engaged with the reduction unit transmitting rotation of electromagnetic reversible clutch P-200 to the plate.

Electromagnetic reversible clutches 2 (P-200) and 5 (2PT-200) are attached to the side walls of housing 11 (Fig.49), clutch 2 serving to follow up the plate tilting angle and thus to shift the sight reticle in the vertical plane. Motion is imparted to clutch 2 through input gear 13 engaged with the gear on the electric motor shaft, and through the reduction unit made up of spur gears 1 and 2 and reversible drive 3 (Fig.51).

The rotation of the output shaft of the electromagnetic reversible clutch is transmitted to the shaft with gears 2 and 1 (Fig.50) through cam coupling 4, spur gears 5 and 6, and a worm-and-wheel pair. Gear 2 is meshed with toothed sector 3 of the plate mounting. Gear 1 engages the toothed sector of the rear cover linked with the knob of the plate tilting mechanism. Mounted on the same axle with gears 1, 2 is a worm gear, which imparts motion to the brush of potentiometer Π_{18} (7) through spur gear pair 25 (Fig.43). The rotation of the worm gear is imparted to the potentiometer brush through a friction clutch. The friction clutch is used first, to decrease the load on electric motor ДГ-6 in case of plate gear train jamming and, second, to enable the sight operator to adjust the plate angle manually (motion of the worm gear cannot be transmitted to the worm).

Electromagnetic clutch 5 (2PT-200) follows up the diameter of the reticle circle (Fig.49).

The electric motor rotates clutch 5 via input gear 13, worm gears 9, 8, spur gear 10 and reversible drive 6.

The output shaft of clutch 5 transmits its rotation as far as the rear cover to the reticle circle follow-up mechanism and to the slider of potentiometer Π_{15} through gear 15.

Mounted under reversible drive 6 (Fig.49) is reticle circle feedback transformer 7. Spring contact 6 (Fig.50) delivering the voltage to the objective heater is arranged on the side wall of housing 11.

When the electromagnetic reversible clutches function as drives, the automatic follow-up systems require that the clutch run-out time is reduced to minimum by special brakes 1 provided for the purpose (Fig.49).

(4) Rear Cover with Sight Reticle Circle Follow-Up Unit

The rear cover unit (Figs 52, 53) is a cast rectangular box with flange accommodating parts of the reticle circle follow-up mechanism, plate tilting mechanism, base setting mechanism and gyro locking lever.

The rotation of the output shaft of electromagnetic clutch 5 is imparted to gear 8 (Fig.52) by gear 15 (Fig.49). Gear 8 is rigidly fixed to worm gear 9 mounted on common axle 7. The axle rotates on two bearings pressed into bracket 6.

The latter is screwed to the front cover on the outer side of the flange. The axle also mounts a gear with limiting pin which engages another gear having a limiting pin, too, thus mechanically limiting the travel of the light tube.

Gear 9 is meshed with gear 4 rigidly fixed to motion screw 5. Via gear 10, gear 4 transmits motion to worm 17 meshed with gear 13 fitted on the axle of receiving potentiometer 14 (Π_{15}) following up the variable diameter reticle circle.

The worm and potentiometer Π_{15} are secured to bracket 16 which is in turn fixed to mirror cone mounting 1. Besides, mounting 1 bears: special spring-loaded mounting 2 with glass plane-parallel plate 15 cemented of two portions chamfered at 45°; motion screw 5 on ball bearings with a special nut which mounts light tube 12; a key. The light tube securing nut travels along motion screw 5 and along the key.

Mounting 1 with the mirror cone forming the luminous reticle circle of variable diameter is attached to the flange. Gear 4 has a cut-out hub rigidly screwed to the motion screw for turning the gear when matching the positions of the brush of potentiometer 14 (Π_{15}) and of the light tube.

Arranged inside the housing of the rear cover is an electric lamp, type CM-46, illuminating the reticle circle and its central pip. The holder of lamp 15 (Fig.53) is

connected to bracket 8 which is in turn attached to throw-out bracket 9 by two adjusting screws 12. When the hinged cover is closed, two springs 10 rigidly attached to the cover, press bracket 8 with the lamp to adjusting screw 5 (Fig.41) and the lamp-holder contacts close the current-carrying contacts on terminal block 4 (Fig.53).

The lamp rays run through: (a) condenser lens 3 (Fig.42) in the cone mounting; opaque (aluminium-plated) disc 4 with transparent pip secured to mounting 1 (Fig.52); small right-angle prism 5 (Fig.42); plate 11 to the centre of the luminous circle; (b) condenser lens 15 in the mounting; mirror 14 to light tube 13.

Condenser lens 15 (Fig.42) is beaded in mounting 23 (Fig.53). The cut of mounting 23 houses mirror 20 pressed up by rubber-padded bracket 21 secured by two screws to mounting 23.

Reflecting plate 11 painted with white enamel is mounted on the hinged cover to improve the illumination of the circle and the pip.

The proper setting of the lamp filament is obtained by shifting bracket 8 relative to throw-out bracket 9 in two perpendicular directions, screws 12 being driven out.

The lamp is brought strictly vertical by means of screw 5 (Fig.41). Prior to this, the locknut should be loosened.

For obtaining the required brightness of the reticle illumination, when replacing lamp 15, use spare parts, tools and accessories of the given set only.

The right wall of the cover body carries rheostat 19 whose handle is rotated to change the electric lamp glow thereby changing the brightness of the sight reticle circle with the central pip. The wall is also provided with knob 16 for tilting the plano-parallel plate by hand. This knob is fitted on the common axle with the gear engaged with sector 18 (Fig.52).

The axle mounts scale 14 (Fig.53) graduated from 0^0 to 12^0. The knob axle with the scale rotates in ball bearings inserted into bracket 13 that is attached to the rear cover

slide blocks screwed to the knob, and a stop screw driven into the cover body wall.

The scale divisions are matched with the index marked on bracket 13.

Sector 17 (Fig.53) is rigidly secured to the axle bearing sector 18 (Fig.52) engaged with mirror unit gear 1 (Fig.50).

The axle with the sectors is in turn fixed on ball bearings in the bracket housed inside the rectangular recess of the rear cover body bottom.

The opposite side wall of the rear cover body carries knob 6 with base scale 7 connected with base data transmitting potentiometer 5 (Π_{14}). The knob is attached to the axle rotating in the bushing screwed to the cover body wall. Inside, the knob is provided with a toothed bushing meshed with the toothed sector which is secured by means of a spring washer and which serves as a locking ratchet.

The base scale is graduated and numbered from 7 to 70 metres. When setting the necessary base, the divisions should be matched with the index marked on the angle bar bearing the potentiometer. At FIXED (НЕПОД.) position, the numerical values of the base correspond to the circle radius in terms of mils.

Secured to the same wall of the body are angle bar 2 with two adjustable resistors and microswitch 24 of the КВ-9-2 type. The latter is intended to break the circuit of electric motors ДГ-4М (M_r) and ДР-3.5М of the computer (M_B) and of lock relay P_9 while shifting the lockpin placed inside the flanged bushing and linked with the cam on the axle of locking lever 1.

A sectional view of microswitch, type КВ-9-2 is shown in Fig.54.

The axle body of the locking lever is screwed to the flange of the rear cover body, its box having inscriptions FIXED (НЕПОД.) and GYRO (ГИРО). One end of the axle is fitted with lever 1 (Fig.53) shaped as a small pedal with knurled surface, the other end bearing a cam with lockpin. The lockpin is engaged with a fork fixed on the axle and secured to the sight head housing. The box incorporates a special locking fixture consisting of a slotted cam and a spring-loaded fork. The spring

secures the looking lever at the extreme positions marked FIXED and GYRO.

Fig.55 represents the wiring diagram of the sight head.

(5) Bracket with Light Filter

Bracket 8 (Fig.56) serves for mounting the sight head on the aircraft. The bracket is cast of aluminium alloy. The lower portion of the bracket is provided with a circular stiffening rib having two holes for adjusting bolts 7 and 10 and two lugs in its front section. The bolts and lugs secure the bracket with the sight head to the aircraft. Attached to the stiffening rib is a braiding with lugs which serves as a bonding wire when mounting the bracket on the aircraft.

The sight head is attached to the bracket by means of bolts (with spring washers) driven into the bosses on the side walls of the bracket.

Steel plugs 12 protect the thread against shearing when turning the steel bolts into bracket 8 made of aluminium alloy.

Secured to the left wall of bracket 8 is bracket 2. The axle bearing all the parts of the light filter, rotates in the bushings pressed into bracket 2. Adapter bracket 3 in the upper portion of the axle couples the axle and rod 5 with light filter 4 (smoky glass disc) fixed to it by means of cover plates. The light filter is intended to dim the target background relative to the reticle illumination brightness.

Lock 6 and knob 9 are fixed to the other end of the axle by means of an involute connection. When knob 9 is rotated, the wedge-shaped tooth of the lock enters the bushing slots of bracket 2 retaining the light filter in two positions: raised (operating) position and lowered position.

The spring of the adjusting screw, fitted into the axle, and the lockpin of lock 6 keep the lock with the knob pressed in the bushing of bracket 2. Light filter bracket 2 mounts range indicator 11 (voltmeter of M-63 type), modified to measure the voltage proportional to the range,

and three selector switches 13 to change over the following modes of operation:

(1) firing "НР-30 - РС "

(2) firing and bombing "С-Б"

(3) operation with the ДУАС transmitter or from the altitude unit "Н-ДУАС".

Attached to two contacts of selector switch "Н-ДУАС" is resistor R_{206}, type МЛТ, intended to maintain the sensitivity of the follow-up system when operating in mode "Н" with the disconnected filter.

The right side wall of bracket 8 mounts housing 15 with signal lamp 16 which indicates the high voltage supplied to the sight when the radar ranging unit is connected. The same housing accomodates selector switch "Radar-optical" changing over the sight for receiving range from the radar ranging unit or from the outer-base optical range finder.

Inside housing 15 there is a block mounting absorbing resistor r_1, type МЛТ, connected to the signal lamp circuit.

The electrical circuits are connected to the bracket by cables 14, 17 with connectors "С" "Ш" and "Р-1". In attachment points the cables are protected against mechanical damage by wire bindings 18.

2. COMPUTER

The sight computer (Fig.58) comprises the main potentiometric components of the sight computing circuits.

The computer is made up of two independent units: a computer proper and an electron relay.

The construction of the electron relay will be described in the section dealing with the construction of the relay on the base-plate.

A. Computer Unit. Gear Train

The computer unit gear train is shown in Fig.59.

Motion from electric motor 6 (ДР-3.5М) is transmitted to electromagnetic reversible clutches (2РТ-200) 7 and 19 by gear pair 5. The rotation of electromagnetic reversible clutch 7 is transmitted to the reduction unit (gears 8 - 13) which turns slider 17 of range potentiometer unit 15(Д).

Unit 15 follows up the range and introduces it into the computing circuits of the sight. Brushes 16 secured to slider 17 slide along the potentiometer windings when slider axle 14 is being turned. Axle 14 mounts range scale 18.

Potentiometer unit 3 follows up indicated time T, the gear train being identical. Slider 2 with the brushes is actuated from electromagnetic reversible clutch 19 via reduction unit 4.

B. Computer Description

The computer is shown in Figs 60, 61.

Angle bars 7 secure range follow-up potentiometer unit 2 and indicated time follow-up potentiometer unit 6 to base plate 8 (Fig.60). Plate 5 (Fig.61) with electromagnetic reversible clutches (2PT-200) 3 and 4 is secured to the above angle bars by screws.

Gear pairs 7 and 8 of the electromagnetic reversible clutches are screwed to plate 5, electric motor 9 being secured to it by metal yoke 10. Bracket 13 attached to the plate mounts high resistor R_{98} cut into the circuit of range receiving potentiometer.

The inner surface of plate 5 carries bracket 1 with four screws 2 bearing the following adjusting resistors:

- R_{37p}, R_{39p} – adjusting resistors of range potentiometer Π_5 for rockets in the ballistic bridge;
- $R_{37н}$, $R_{39н}$ – adjusting resistors of range potentiometer Π_4 for rifled weapons in the ballistic bridge;
- R_7, R_8, R_9 – adjusting resistors of time receiving potentiometer Π_1 in the ballistic bridge;
- R_{53}, R_{63} – adjusting resistors of the time receiving potentiometer in the additional winding circuits for the vertical and horizontal channels (Π_8, Π_9);
- R^x_{31}, R^x_{32} – tachogenerator adjusting feedback resistors of clutches 2PT-200 in the range (Д) and time (T) follow-up circuits.

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Negative feedback transformers Tp-2, Tp-3 are arranged on the plate.

On the opposite side of bracket 1, the adjusting resistors are held by strut 3 (Fig.60) mounting a group of fixed resistors 14. These fixed resistors are connected to various circuits of the sight electrical system:

R_{173} - to the circuit of ballistic bridge time receiving potentiometer Π_1;
R_{073} - to the prediction circuit;
R_{310} - to the circuit of sight reticle circle potentiometer Π_{16};
r_{17} - to the circuit of range indicator potentiometer Π_{17};
R_{098} - to range follow-up bridge (to the circuit of potentiometer Π_{11}).

Connector plugs 12 and 17 are meant for delivering power supply and for connection to other units of the sight. The computing mechanism and the electron relay are connected by means of flat connector 11 (Fig.61). The latter is rigidly secured to the base plate by screws. The corresponding socket of the connector is made floating. It is secured to the electron relay plate via intermediate discs thereby ensuring centering of the socket with the terminal block when the two parts of the computer are joined together. The base plate also mounts two duct capacitors $C\Pi_5$ and $C\Pi_6$ for suppressing noises produced by operating electric motor ДР-3.5м. The lower portion of the plate mounts selector switch Пкр-2 intended to switch the control winding of the electron relay magnetic amplifier depending on the type of the radar ranging unit used. The switch is closed by a protective jacket, its lever being held against spontaneous change-over by sleeve 15 (Fig.60).

Riveted to base plate 8 are angle bars 9 and 13 (Fig.60) that receive screws fastening the computer jacket.

The unit protecting jacket is riveted up of three parts. Its central portion is provided with inspection holes covered by organic glass plates. The base plate mounts resistors R_{97} and R_{99} connected to the circuit of the range receiving potentiometer Π_{11}.

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The base plate is provided with four threaded bushings 12 (Fig.61) which receive the electron relay fastening screws.

The computer mechanism is secured to the aircraft by means of four holes in the base plate edged with rubber eyelets 10 (Fig.60) and metal bushings 11. Attached to base plate 8 is a braiding with lugs serving as a bonding wire when the computer unit is mounted on the aircraft.

The potentiometer units are shown in Figs 62 and 63.

The circular recesses (Fig.62) of cylindrical housing 18 receive holders 17 with potentiometer formers 15 pressed into them. There are five potentiometers altogether:

Π_{11} - range receiving potentiometer;

Π_4 and Π_5 - range transmitting potentiometers in the ballistic bridge;

Π_{17} - range transmitting potentiometer for the range indicator;

Π_{16} - range transmitting potentiometer in the reticle circle follow-up bridge;

The ends of the potentiometer windings are brought to terminal block 19 secured to unit housing 18.

Potentiometer brushes 6 are secured to textolite slider 7 which is, in turn, fixed to bushing 10 connected to axle 20. The latter is mounted in the unit housing on the ball bearings. Fitted on the other end of the axle, opposite the slider, is bushing 21 with a lugged flange. Driven gear 23 is rigidly fixed to bushing 21.

Driven gear 23 meshes double gear 1 whose axle is flanged strut 2 secured to the unit housing. Double gear 1 is engaged with gear 3 of bracket 4 attached to cylindrical housing 18. Gear 24 is engaged with driving gear 8 (Fig.59) of electromagnetic reversible clutch 7.

The unit driven gear carries limiting pin 22 (Fig.62) with insulating sleeve slipped over it. Driven gear 23 turning, the limiting pin comes clear of the stop and breaks contact plates 5. Then the lug of bushing 21 bears against the stop rubber pad keeping gear 23 against further rotation. The contact plates mounted on the part secured to the housing

are intended to break the circuit of the winding of electromagnetic reversible clutch 2PT-200.

The current is fed to brushes 6 of slider 7 in the following way.

The slider has strut 8 with terminals 9 soldered to the brushes. The terminals are pressed into the strut hole. Spiral springs 13 are welded to the ends of the terminals protruding above strut 8. These springs are assembled on the bushing and insulated by washers 14. Every spring has a lead (terminal) welded to the spring. The whole assembly is screwed to bracket 11 mounted on the cylindrical housing and locked by nut 12.

Range scale 16 is screwed to the unit axle flange. The index for taking off the readings is marked on the cylindrical housing.

The indicated flight time potentiometer unit (Fig.63) and the range potentiometer unit are identical in design.

Listed below are potentiometers mounted into cylindrical housing 28 similar to that of the range unit:

- Π_1 — potentiometer receiving indicated flight time T;
- Π_7 — potentiometer transmitting indicated flight time for the prediction circuit;
- Π_8 and Π_9 — indicated flight time potentiometers in the additional winding circuits for the vertical and horizontal channels;
- Π_{26} — potentiometer introducing the indicated time into the computing circuit of the aircraft slip correction horizontal component.

Unit slider 30 is turned through reduction unit 26 assembled of the parts specified above for the range unit. The reduction unit is driven by electromagnetic reversible clutch 19 (Fig.59).

Indicated flight time scale 27 (Fig.63) is attached to the slider axle flange by screws. The readings are taken off the index marked on the cylindrical housing.

The wiring diagram of the computer is presented in Fig.64.

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3. ZERO GYRO

The zero gyro (Fig.65) measures the fighter angular speed necessary for computing the additional angle lead and angle of elevation.

It includes the zero proper and its base plate.

The zero gyro is arranged inside the heat-insulated jacket and secured to base plate 4 (Fig.65) provided with adjusting elements for proper orientation of the zero gyro planes relative to the aircraft axes.

The heat-insulated jacket houses adjusting elements for the zero gyro circuits and the external heaters.

A. Zero Gyro

The zero gyro is made up of three main assemblies: a gyro with electric motor, inductive transmitter and magnetic correction system.

The zero gyro design is shown in Fig.66.

(a) Gyro with Electric Motor

The zero gyro has three degrees of freedom, its design being similar to the sight head gyro.

One end of axle 14 carries armature 30 of the inductive transmitter, and the other end - aluminium dome 8 forming a part of the gyro correction system. The gyro is freely mounted on gimbal 27 whose spin axes are perpendicular to each other. Due to this gimbal, the gyro may travel in any plane.

Mounting 23 with bushing 24 beaded over it is screwed to the cone portion of gyro axle 14. Locking screws 31 secure armature 30 to bushing 24, balancing screws 1 being meant for static and dynamic balancing of the gyro in mounting 23. Preliminary static balancing is done by shims 25.

Holder 28 embraces the inner race of ball bearing 26 secured by bushing 19 of the gyro centrifugal lock.

The outer ring of bearing 26 composed of two parts is beaded in bushing 6 securing the holder with the gyro and rotor to cover 5. Permalloy cover 5 is a part of the magnetic circuit of the zero correction system. The external side of

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cover 5 has four poles bored along the sphere concentric with the sphere of the aluminium dome.

Rotor 4 is a shorted rotor of an A.C. single-phase asynchronous electric motor comprised of segments made of 0.35-mm thick steel 344. They are placed between the copper flanges and riveted to them by copper rivets. This riveted assembly is beaded in bushing 2 that rotates in the ball bearing relative to bushing 6.

Stator 20 of the asynchronous motor is also assembled of segments made of 0.35-mm thick steel 344. The segments are pressed to base plate 21 by ring 3.

The grooves of the stator assembly house two windings of the electric motor.

The asynchronous motor has an excitation winding and a control winding. The voltage phases in these windings should be shifted relative to each other, which is necessary for creating the rotating magnetic field that rotates the electric motor rotor.

The phases in the windings are shifted by placing a capacitor in the control winding circuit.

Equal resistances of the zero gyro electric motor stator windings run into 118 ohms, each winding being composed of two series-connected windings of 59-ohm resistance each.

The stator windings are fed with 115 V, 400 c.p.s., one-phase current and have a common point connected to one of the supply wires. The ins of the windings are connected to the other wire, the control winding being connected through the capacitor.

Screen 22 is fixed to ring 3. Cover 5 carrying the gyro and the rotor is attached to base plate 21.

The gyro lock is a device based on the centrifugal forces effect. Lock bushing 19 is screwed into holder 28 and provided with a cylindrical lug. Milled in the lug are three recesses for three rods 7 with weights 13 soldered to them. Rods 7 are inserted into these recesses and fixed to them by means of tubular axles relative to which they can rotate. Rollers 12 are screwed to weights 13 to arrest the gyro axle when it must be locked. Every weight 13 with roller 12

is pressed to the gyro axle by a coil spring. One end of this spring is brought inside the tubular axle of rod 7, and the other - into the groove of rod 7. Two springs of the lock are made more rigid, than the third one. This difference in the resilient properties meets the requirements of the proper functioning of the lock as two points of the spring application are made more rigid than the third one.

The lock rotates together with the rotor and the gyro. Under certain r.p.m., centrifugal forces of the weights begin to exceed the opposing efforts of the springs, and weight-loaded rods 7 go apart to release the gyro axle.

The gyro is locked when 2700 r.p.m. have been gained, the operating r.p.m. of the zero amounting to 3200.

(b) Inductive Transmitter

The inductive transmitter is shown in Fig.67.

Eight coils 2 of the inductive transmitter are arranged on base plate 1 by pairs in two mutually perpendicular planes. Inside every pair of the coils runs common core 3 assembled of permalloy discs, 0.25-mm thick. On the side of base plate 1 the cores are bored spherically concentric with the sphere of the gyro armature.

One coil of every pair (1500 turns, 80 ohms) is an excitation coil. All the four excitation coils are connected in series to 115 V, 400 c.p.s. mains via damping resistor $P_{Д}$. The other four coils (3000 turns, 195 ohms) are connected in pairs to form circuits of the inductive transmitter in the horizontal and vertical planes as parts of the respective amplification systems on the vertical and horizontal channels. Every pair of the coils arranged in one or the other plane is connected in series so that the electromotive forces induced in them oppose each other.

Operation of the inductive transmitter is based on obtaining differently directed electromotive forces of different values induced when the gyro spin axis comes off the zero position. When the gyro has turned through a certain angle, the electromotive force increases in the coil where the armature portion overlapped by the core is larger, and

decreases in the coil where the overlapped portion is smaller. The difference of the electromotive forces is fed to the amplifier which converts it into the zero gyro correction current for the respective plane. The inductive transmitter coils are assembled on base plate 1 screwed to gyroscope base plate 21 (Fig.66).

(c) Gyro Correction System

Housing 9 of the magnetic correction system is screwed to base plate 21 of the gyro on the side opposite to the inductive transmitter (Fig.66).

Permalloy housing 9, core 11 and cover 5 form magnetic circuit of the correction system. Cores 11 are attached to housing 9 by means of bushings 17. Cores 11 are bored spherically concentric with the sphere of gyro dome 8. Cores 11 can travel along their longitudinal axis adjusting the air gap. They are set rigid by clamps in bushings 17.

The main magnetic flux of the correction system is formed by ampere-turns of the main coil wound on former 18.

Ampere-turns of correction coils 16 create an additional magnetic flux. These coils are arranged on the cores in pairs as components of the correction system of the vertical and horizontal channels. Every pair of the coils placed in the same plane (horizontal or vertical) is connected in series, their windings are wound in opposite directions. The windings outs are connected to the inductive transmitter amplifier output.

Once the voltage has appeared across the inductive transmitter output, the correction coils in question pass the current proportional to the angular speed of the aircraft turn in the respective plane. This current induces an additional magnetic flux bringing the zero gyro back to the zero position.

165-ohm additional coils for the vertical channel have 3000 turns each, while 100-ohm additional coils - for the horizontal channel have 2000 turns each. The horizontal channel coils carry 360-ohm additional winding with 3000 turns.

Apart from the correction coils, the cores have sighting circuit coils mounted in the vertical plane and comprised of 11-ohm, 135 ampere-turns. The sighting circuit coils create ampere-turns making the zero gyro form additional correction ampere-turns so that the sight plots the variable component of the elevation angle in its field of view. The coils are wound on formers fitted on flanges 10. The latter are screwed to housing 9.

The main coil of the gyro is shown in Fig.68.

The main correction winding and two heater windings are wound on former 2. Holder 1 with thermoregulator T_1 is soldered to the inner side of the former. Lower heater winding O_2 of former 2 is made of two series-connected bifilar windings of 13 ohms each.

The centre winding of former 2 is the main coil of the zero gyro correction system. It is made as a layer winding with 900 turns laying 40-ohm resistance.

54-ohm upper bifilar winding O_1 of former 2 serves heating purposes too.

Thermoregulator 3 (Fig.68) is adjusted to be disconnected under $T = 70^{\circ}C$. The contacts of the regulator controlling the relay cut off both heater windings.

The thermoregulators of the zero gyro and of the main gyro are similar in design (See Para.1 of the present Chapter).

B. Zero Gyro Base Plate

Fig.65 shows how the zero gyro is attached to the base plate.

Zero gyro 12 is housed in jacket 11 with the zero gyro outer heaters.

Attached to four sides of jacket 11 are 15-ohm wire heaters O_4 - O_7. The heaters are connected by pairs in parallel and in series. Contacts of relay P_{17} apply 27 V voltage to the heaters. Relay P_{17} is governed by thermoregulator T_2 adjusted to be disconnected under $T = +30^{\circ}C$.

The base plate mounts bracket 8 that carries two relays and the following resistors:

P_{17} - gyro external heating relay disconnected under +30°C;

P_{12} - gyro internal heating relay disconnected under +70°C;

R_{49} - main coil circuit adjusting resistor;

R_{203}- fixed resistor;

R_{216}- adjusting resistor of the K_{HTO} coil circuit.

Besides, bracket 8 mounts thermoregulator T_2 (disconnected at T = +30°C) to govern the external heaters, and terminal block 14 to secure the wiring.

Capacitors C_1^x; C_2^x; C_5 and C_6 (10) of the inductive transmitter and electric motor capacitor C_4 are secured to bracket 8 together with resistor r_4 of the electric motor control winding, spark-quenching capacitors Cu_1 and Cu_2 and resistors ru_1, ru_2.

Outside, the zero gyro with the brackets is protected by a jacket with heat-insulating rubber gaskets. Screws attach the jacket to the adapter, and the latter is secured to base plate 4.

The zero gyro planes are aligned with the sight head planes and with the aircraft axes by means of a special matching device comprised of the ball support and two bushings with springs.

Level 13 is mounted on the base plate to check whether the zero gyro is correctly arranged on the aircraft.

The mechanism described is connected to the control box and to the zero gyro amplifier by a cable terminating in connectors УНГ (for the zero gyro amplifier) and НГ (for the control box).

The wiring diagram of the zero gyro is presented in Fig.69.

4. ZERO GYRO AMPLIFIER

The zero gyro amplifier is made as a separate unit (Fig.70).

Horizontal plate 15 (Fig.70) mounts:

4 - bias circuit capacitors C_6, C_7, C_8, C_9;

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2, 6 - interstage and feedback transformers Tp-2, Tp-3, Tp-4, Tp-5 of the vertical and horizontal channels;

12 - valve 6Н1П($Л_5$) of the horizontal and vertical channels voltage amplifier;

5 - valves 6Н12С ($Л_1$, $Л_2$, $Л_3$, $Л_4$) of the power amplifier stages;

13 - kenotron 6Ц4П ($Л_6$);

9 - fuse protecting the amplifier during short-circuiting;

11 - selenium rectifiers $ВС_3$, $ВС_4$ of bias circuits of valves $Л_3$, $Л_4$;

8 - reference connector for checking the amplifier operation;

3 - rectifier circuit filter capacitor C_1;

14 - selenium rectifiers $ВС_1$, $ВС_2$ of bias circuits of valves $Л_1$, $Л_2$;

16 - output filter capacitor C_{11}.

The bottom of horizontal plate 4 (Fig.71) mounts:

2 - power transformer Tp-1;

5 and 7 - adjusting resistors ПС-1000;

1 - panel with resistors R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{11}, R_{13}, R_{15};

6 - output filter capacitor C_{10};

3 - automatic bias filter capacitors C_3, C_5.

All components of the amplifier are secured either directly to plate 4 or by means of adapters.

Above and below, the amplifier components are protected by jackets against mechanical damage. The jackets are provided with holes and louvers for better cooling of the amplifier components.

Spring-loaded clamps are meant for reliable attachment of the valves.

When valves $Л_1$, $Л_2$, $Л_3$ and $Л_4$ are replaced, the spring-loaded clamps may be removed together with the cover.

The amplifier is mounted on spring shock-absorbers 1 (Fig.70) to ensure reliable operation of the amplifier components under vibration conditions (from 10 cycles and over) and to absorb shocks during take-off and landing.

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The amplifier is connected with the sight zero gyro by means of cable 7 (Fig.70) terminating in connector 10.

The lower part of the amplifier carries metal braiding with lugs serving as a bonding wire when the unit is mounted on the aircraft.

Fig.72 represents the wiring diagram of the zero gyro amplifier.

5. CONTROL BOX

The control box serves for switching over the electrical circuits of the sight and for controlling them under different sight operating modes. The control box general view is shown in Fig.73.

The control box comprises two units: distribution box 1 and relay box 2. Distribution box 1 and relay box 2 are connected by three 20-pin flat connectors 3 and are attached to each other by six screws 4.

A. Distribution Box

Distribution box (Fig.75) changes over all circuits of the sight. It is comprised of housing 3 accommodating distribution blocks 4, brackets 6 with connectors 5 that serve connection of the distribution box and the relay box. Cables 8 connecting the distribution box to the sight assembly units are attached to the box housing by clamps 7.

The distribution box is provided with reference connector 2 mounted on the bracket riveted to the housing for checking various circuits when the sight is cut in for operation.

The reference connector is protected by plug 7 (Fig.73) which is removed when checking the sight by means of КПП5СЛ testing equipment. Besides, the distribution box houses: resistors R_6, R_{36} of the ballistic bridge, resistor r_{11} of the radar ranging unit signalling circuit, R_{73} of the prediction circuit, R_{057} and R_{067} of the horizontal and vertical correction circuits.

The holes made in the distribution box housing serve for securing the relay box and the control box to the aircraft.

Above and below, the distribution box is protected by covers attached to the housing by screws.

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B. Relay Box

The relay box (Figs 76 and 77) houses elements governing operation of the sight circuits at different modes of operation. All elements of the relay box are assembled on common plate 4. Relays P_2, P_3, mounted on the plate, cut in the ballistic bridge resistor groups. The plate also carries locking relay P_9, relay P_8 controlling the radar ranging unit and the range manual control, ranging unit type selector switch Пкр-1.

The same plate mounts a bracket with two fuses Пр1 (3) and Пр2 (2), connected to 115 V circuits of the primary winding of electron relay transformers of the computer and a relay on the base-plate. Attached to plate 4 are two brackets, bracket 1 mounting relay P_{30} of the gyro deflection angle electromagnetic limiter and break-off signalling relay $P_{СИГ}$. Bracket 6, mounting removable unit 6 (Fig.73), has a latch to secure the unit and to prevent it against dropping out at sharp jerks and impacts. The unit is connected with the control box through adapter terminal block 8. Bracket 6 mounts also relay P_{15} of the damping circuit.

Plate 4 carries adjusting resistors R_{20}, R_{66}, R_{55}, R_{101}, R_{52}, R_{58}, of the circuit computing the aircraft slipping correction; R_{47}, R_{48} - of the sighting circuit; R_{57}, R_{67} - of the correction circuit; R_{201} - of the circuit computing the reticle circle size; R_{189} - of the break-off signalling circuit; fixed resistors R_{048}, R_{077}, R_{188}, R_{178}, R_{78}, R_{93}, R_{215} of the sight computing circuits; capacitors C_{17} and C_{18}, type ЭТО; high-ohmic resistor R_{0205} and resistor R_{212} of the МЛТ type, connected to the ДУАС transmitter filter circuit; capacitor C_3 of the gyro deflection angle electromagnetic limiter.

The bracket of the ranging unit, type selector switch, mounts resistors R_{207} and R_{093}, type МЛТ. The resistors are soldered to a block.

Arranged in the lower portion of plate 4, on bracket 9 (Fig.77) are flat connectors (to connect the distribution

box) and resistors R_2, R_{95}, R_{96}, R_{26}, R_{92}, R_{91}, R_{16}, R_{214}, R_{210}, R_{211}, R_{208}, R_{209}, R_{32}, R_{10}, R_{010}, R_{50}, $R_{15}k$, R_{152}, R_{42}, R_{213}, $R_{25}k$, R_{154}, R_{40}, R_{38}, R_{12}, R_{54}, R_{56}; R_{22}, r_3, r_7, as well as fixed resistors R_{205}, R_{204} of МЛТ type. All the above resistors are arranged in the sight computing circuit.

The side wall of the relay box base-plate mounts switch Пкр-3 (10) which changes over the resistors making allowance for the overload at high altitudes for different types of aircraft.

From above, the relay box is protected by jacket 5 (Fig.73) and from below - by cover 8 (Fig.74), both being fixed to the plate angle bars by screws.

The relay box is provided with a bonding wire (braiding with lugs) connected to the aircraft structure when mounting the unit.

Removable ballistic unit 6 (Fig.73) consists of bracket 1 which mounts ballistic resistors 2 (Fig.78). The ballistic unit is connected with the sight by two blocks 3 of РП type. The unit is protected by jacket 4.

Figs 79 and 80 represent the wiring diagrams of the distribution and relay boxes.

The ballistic units electrical diagram is shown in Fig.39.

6. ALTITUDE UNIT

The altitude unit (Fig.82) performs stageless introduction of the altitude into the sight computing circuits.

The altitude unit utilizes the principle of the potentiometer follow-up system. The aneroid box unit ВД-20 (ВД-28) serves as a mechanical transmitter of altitude.

A. Altitude Unit Gear Train

Gear train of the altitude unit is shown in Fig.81.

When the altitude changes, the sagging of aneroid capsules 1 is convered by crank mechanism 2 and pinion 3 into turning of contacts 4 relative to disc 5. The disc is

[redacted]

provided with two slip half-rings insulated from each other. In the neutral position, contacts 4 stand on the insulated portion of disc 5, and there is no voltage across the control windings of electric motor 6.

When the contacts clear the insulated portion of the disc sliding over the half-ring and the contacts, the electric motor control winding supply circuit is closed, the electric motor starts rotating, and sets in motion contact disc 5 via the two-stage worm reduction unit. Due to the electric motor supply circuit design, the disc turns towards matching the insulated portion with the contacts. The disc turns and the brushes of potentiometers 7 start rotating simultaneously, as the disc and the axle with brushes receive motion from output shaft 8 of the worm reduction unit. The rotation stops when the contacts have reached the insulated portion of the disc. The matching achieved, the electric motor control winding supply circuit breaks, and the system comes to standstill.

Thus, the potentiometers keep following up the altitude transmitted by the aneroid capsules.

The altitude unit is actuated by two-phase asynchronous electric motor ДИД-0.5 whose windings are connected to 115 V, 400 c.p.s. mains through the transformer.

B. Description of Altitude Unit

The altitude unit is three main units, including airtight chamber unit 8, potentiometer unit 4, and housing unit 18 (Figs 82, 83).

The airtight chamber incorporates two main elements of the altitude unit: altitude transmitter (aneroid capsules 2) and a potentiometer follow-up system accommodated inside the airtight housing 7 closely shut by cover 10 with gasket 9.

The inner space of the airtight chamber communicates with the static chamber of the Pitot static tube via pipe connection 11. The contact disc placed in the airtight chamber is connected to sealed shaft 15 of special design by means of a cruciform clutch. The gear threaded on shaft 15 is engaged with the gear of the reduction unit

output shaft mounted in the housing unit. The gearing may be adjusted during assembly by turning the airtight chamber relative to the housing unit. The side of the airtight chamber opposing shaft 15 is provided with a boss bearing the washer with a clamp. The latter retains cable 12 and jacket 1 protecting the altitude unit against moisture and dust.

One of the side walls of the airtight chamber accommodates block 14 making connection between the potentiometer follow-up system and the electric motor control windings.

Arranged on the side wall of the airtight chamber are fixed resistors R_{62}, R_{60}, R_{68} of potentiometer Π_{19} circuit. The airtight chamber unit is secured to housing unit 3 with four screws and then after final adjustment of shaft 15 engagement with the reduction unit is placed on the locating pins.

The small-size double-stage worm reduction unit is put inside housing 3 which also accommodates the electric motor supply transformer, adjusting resistors 5 and capacitor 6 ensuring shift of the voltage phases in the excitation and control windings of the electric motor.

Potentiometer unit 4 is made up of three concentric formers with the potentiometer windings: Π_2, Π_3 - introducing function $f'(H)$ into the ballistic bridge, Π_{19} - introducing function $f(V_{cp.H}; \theta_H)$ into the bridge computing the aircraft slip correction vertical component.

Block 23 mounting the potentiometer brushes is rigidly attached to the unit axle. The block also mounts a group of slip rings 19. Every ring is connected to the respective brush of the potentiometer by wires 17. Besides, every ring is connected to brushes 22 with block 24 screwed to the potentiometer housing. The unit axle terminates in gear 21 meshed with the aforesaid output shaft of the reduction unit. The other end of the axle is provided with a bushing having a limiting pin which presses on the limit switch contacts to disconnect the electric motor at extreme values of the altitude thus protecting the altitude unit against damage. The bushing mounts altitude scale 13. The altitude

followed up by the unit is read off through the window made in cover 26.

The formers with the windings of potentiometers $П_3$ and $П_{19}$ may turn relative to fixed potentiometer $П_2$ and, consequently, to the housing, thus adjusting is achieved. Besides, the potentiometer housing may turn in the unit housing for adjustment purposes as it is meshed with the reduction unit. After adjustment, the potentiometer housing is lockpinned to the altitude unit housing and secured by screws.

The wiring diagram of the altitude unit is presented in Fig.84.

7. RELAY WITH BASE PLATE

The relay mounted on a separate base plate is meant to automatically form the sight reticle circle in the sight head and to compute the aircraft slip correction vertical component.

Fig.85 shows the general view of the relay unit mounted on the base plate. The unit comprises base plate 1 and electron relay 2 differing in no way from the electron relay of the computer.

Description of Relay

All the elements of the electron relay (Fig.87) are arranged on base plate 12 and vertical angular panel 4 attached to the base plate.

One side of panel 4 mounts: two small-size magnetic amplifiers У1 (7) (Fig.87) of time T (ДК) follow-up channel and У2(8) of Д(ШШ) follow-up channel, four bantam valves $Л_1$, $Л_2$, $Л_3$, $Л_4$ (2, 3, 5, 6), transformer Тр-3 (16), potentiometers R_{20}, R_2 (13, 15) to adjust the relay sensitivity, and adjusting resistors R_{12}, R_{13} (14).

The other side of the panel (Fig.86) mounts: two selenium rectifiers 7 ($СВ_1$, $СВ_2$); block 2 with resistors R_4, R_{22}, R_{14}, R_{15}, R_{16}, R_{17}, R_{18}, R_8, R_9, R_{10}, R_{26}, R_{27}, R_{28}, R_{29}, R_3, R_5, R_6, R_{21}, R_{23}, R_{24}, R_1, R_7, R_{11}, R_{25}; valve panels 1; fuses 4 ($ПП_1$, $ПП_3$) arranged on the block with

[redacted]

resistors. Resistor R_{19} (Fig.89) is arranged on the base plate.

The upper part of the base plate (Fig.87) mounts two polarised relays PЭ - Assy 41 P_1, P_2 (1, 10) and two capacitors, type МБГП, C_{6-7}, C_{13-14} (11). The lower part of the base plate accommodates two capacitors, type КБГ, C_2, C_9; two capacitors, type МБГП, C_{15}, C_{16}; 20-contact connector; mounting plate with capacitors, type КБГ-И, C_1, C_3, C_4, C_5, C_8, C_{10}, C_{11}, C_{12}; filter resistor R_{30}.

Attached to the base plate lower part is bottom 9 (Fig.87).

The relay is protected by jacket 3 (Fig.86). Beaded in base plate 8 are hollow struts 6. The relay is secured to the computer or to the base plate by screws passing through struts 6.

The relay wiring diagram is presented in Fig.88.

The base plate (Fig.89) is made up of duralumin base 5 provided with three holes housing shock absorbers 4 for mounting the relay unit on the aircraft.

Secured to the base plate is cable 2 intended for connection between the electron relay and the sight set. The cable terminates in connector 3.

Beneath the base plate, the cable leads run to the flat connector socket which receives the plug of the connector attached to the relay.

Flat connector 1 is rigidly attached to base 5. Leads running from cable 2 to connector 1 are protected by a special cover. Mounted under the cover is an adjusting resistor of the tachogenerator excitation circuit of the reversible electromagnetic clutch 2PT-200 placed in the sight head and forming a part of the sight reticle circle follow-up gear train. The base has braiding 6 with lugs serving as a bonding wire when mounting the relay unit on the aircraft.

The relay base plate wiring diagram is presented in Fig.90.

8. VOLTAGE REGULATOR CH-4

The voltage regulator, with the jacket and magnetic screes removed, is presented in Fig.91.

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Plate 10 carries on top: carbon regulator 9, two valves 15, bracket 16 with resistors and sensitive element 5 in shock-absorbing frame 4; mounted on the underside of the plate are three fixed resistors (Fig.92), capacitors 11, connector 1 and a terminal block.

Shock-absorbing frame 4 is protected with magnetic screen 6.

The sensitive element is attached to frame 4 by means of springs 7. It is provided with shock-absorbing springs 22 and limiting springs 2.

Plate 10 is mounted on common plate 12 (Fig.92) by means of struts 17 (Fig.91).

The regulator mechanism is protected by jacket 8. Plate 12 of the voltage regulator is mounted on special base plate 13 equipped with four shock absorbers 14 made of rubber and metal.

The construction of the carbon regulator is shown in Fig.93.

The regulator consists of an electromagnet with blade springs and of a carbon pile.

The electromagnet comprises core 7 and a coil with two windings: main winding 4, and additional winding 3, enclosed in housing 5.

Core 7 of the electromagnet is screwed into cover 6 of housing 5. Rotation of core 7 enables adjustment of the air gap between the core and electromagnet armature 10. The latter is rigidly connected with blade springs 9 resting against washer 8.

Carbon pile 2 is comprised of carbon discs compressed between two carbon contacts electrically insulated from the regulator components. One contact is secured to adjusting screw 13, the other contact 11, to electromagnet armature 10.

Carbon pile 2 is placed into insulating porcelain tube 12 which is arranged in radiator body 1 whose fins ensure necessary heat exchange.

Resistance of carbon pile 2 depends mainly on contact resistance between the discs which varies when the carbon pile compression is changed within the limits of its resilience.

The compression of carbon pile 2 is determined by the difference of two forces applied to armature 10: the force developed by springs 9 and the electromagnet pull.

Since the electromagnet pull depends on the number of the ampere-turns of the electromagnet winding the carbon-pile resistance and the output voltage are also determined by the number of the ampere-turns.

When the stabilizer is functioning, the sum of forces applied to armature 10 under stable operating conditions is equal to zero. Changes in the input voltage or the load bring about changes in the output voltage and, consequently, in the ampere-turns of electromagnet main winding 4, so that the equilibrium of forces applied to armature 10 is disturbed. The resultant force causes the armature to move in order to restore the equilibrium of forces applied to it. When the armature travels, the compression of the carbon pile changes thereby changing the output voltage. The system is designed so that coarse (static) stabilization of the voltage is ensured when the forces applied to the armature are in equilibrium.

Fine (astatic) stabilization of voltage is obtained by additionally changing the pressure exerted on the carbon pile by varying the electromagnet ampere-turns. The latter are adjusted by the sensitive element which changes the current in additional winding 3.

The construction of the sensitive element is shown in Fig.94.

The main components of the element are a permanent magnet and an electromagnet.

Frame 4 of the sensitive element with current-carrying springs 3 and contacts 2 is mounted together with pole shoes 1 on bracket 6.

The precision of voltage stabilization is dependent upon the construction of the sensitive element and frame 4, as well as on the magnetomotive force and stability of the permanent magnet.

Permanent magnet 5 made of highly coercive material (alloy "Magnico") is subjected to stabilization treatment (magnetized

[redacted]

up to complete saturation and demagnetized down to a certain value).

In view of the difficulties involved in precise magnetization of permanent magnets the sensitive element is provided with a magnetic shunt enabling the magnetomotive force of the permanent magnet to be smoothly varied. The mechanism of the sensitive element is secured to angle bar 7 and protected on top by a cover.

9. BRIEF DESCRIPTION OF ELECTRIC MOTORS, TYPES ДГ-4М, ДГ-6 and ДР-3.5М

Electric motors, types ДГ-4М, (ДГ-6) and ДР-3.5М are two-pole machines of the enclosed type. The electric motor ДГ-4М (ДГ-6) has two symmetrical excitation windings connected in series. The centrifugal regulator automatically cuts in and out the resistor shunting the armature winding to maintain r.p.m. constant when the shaft load and supply voltage are changed.

The circuit diagram of the electric motor ДГ-4М is shown in Fig.96.

Motor Characteristics

Supply voltage .... 27 V ± 10%
Shaft power at U = 27 V .... at least 3.5 W
Current intensity .... not exceeding 0.7 A
r.p.m. .... n = 4900 - 5400

Electric motor ДГ-6 differs from the ДГ-4М motor in that it is 8 mm longer. Its shaft power is 6 W at U = 27 V, the current consumed not exceeding 1 A; n = 4200 - 5600 r.p.m.

Electric motor ДР-3.5М belongs to types of machines characterized by separate excitation from permanent magnets.

Motor Characteristics

Supply voltage .... 27 V;
Consumed current .... not over 0.35 A;
Shaft maximum power at n = 8500 r.p.m. ±10% at least 3.5 W.

The circuit diagram of the electric motor ДР-3.5М is shown in Fig.99.

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10. MAIN COMPONENTS OF SIGHT CIRCUIT

The present section deals with the purpose and design of the main components of the АСП-5НД sight circuit.

All computing circuits of the sight are made as potentiometer bridge circuits. The basic elements of the circuits are potentiometers (voltage dividers) made of wire possessing high specific resistance. The ends of potentiometers receive voltage, any part of which may be taken off the potentiometer by means of the sliding brush (slider).

The sight has transmitting potentiometer ПД and receiving potentiometer ПП. The external view of these potentiometers is shown in Fig.101.

They are absolutely identical in design except that the receiving potentiometers are provided with limit switches which de-energize the potentiometer circuit when the brush reaches its extreme positions.

The sight employs unit-type potentiometers $П_1$, $П_7$, $П_8$ and so on (Fig.127) described above.

Adjusting resistors ПС-50, ПС-200 and ПС-1000 are intended to compensate for deviations of resistance in the potentiometer circuits (due to inaccuracy of manufacture) and to adjust the electrical circuits to meet the required settings. Every adjustable resistor is a variable wire resistor, the figure standing after letters ПС designating the resistance value in ohms.

All types of the adjusting resistors are identically designed (Fig.102).

Besides, the sight utilizes high-ohmic adjusting resistor ПС-5000 (See the Description of the Computer above). General view of the resistor is shown in Fig.103.

The potentiometer computing systems are governed by the electromagnetic reversible clutches with various types of the relays. These are:

(1) Relays PC-13-10

Small-size electromagnetic D.C. relays of the PC-13-10 or PCM-1 type are used for switching over the sight circuits.

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The PC-13-10 relay has six contact groups, each group having normally opened and normally closed contacts. Relays P_1, P_2, P_8, P_9 are of the PC-13-10 type. Relay PCM-1 has two groups of normally-opened contacts, it is arranged in the damping circuit (P_{15}).

(2) Relays PП-5 and PП-7

These are small-size plug-in polarised relays; relay type PП-5, having three positions, and biassed relay of PП-7 type, having two positions. Relay PП-7 of the sight circuit operates in the circuit of the electromagnetic limiter P_{30}. The electron relays use relays PП-5 modified as relays Assy 41.

(3) Heater Relay 4H-Assy 1-323

It is a small-size electromagnetic D.C. relay intended for changing over the heater electrical circuits.

The relay has only one contact group operating for closing. Relays P_{11}, P_{12}, P_{17} of the sight come under the 4H-Assy 1-323 type.

Apart from the sight circuit components listed above, the circuit comprises fixed resistors and capacitors shown in Fig.104.

An example of designating the airtight metallized-paper capacitor in rectangular housing of the second model, rated for 200 V (operating voltage), group A, rated capacitance of 10 mfd, class II, permissible deviation of capacitance from the rated value not exceeding ±10%:

capacitor МБГП-2-200-A-10-II-ГОСТ 7112-54.

All the aforesaid components of the sight circuit are connected by wire МГШВ ТУК 282-57 in accordance with the key and wiring diagrams of the sight.

Part II

The second part of this Description deals with the operation of the sight. It includes:

(1) mounting of the sight on the aircraft;

(2) connection of the sight with the radar ranging units and ДУАС transmitter;

(3) checking of the sight on the ground;

(4) operation of the sight in the air and instructions on combat employment;

(5) routine maintenance jobs;

(6) checking of the sight by means of testing equiment КП5СД;

(7) trasportation and storage.

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Chapter I

REQUIREMENTS FOR SIGHT MOUNTING AND ARRANGEMENT ON AIRCRAFT

1. GENERAL REQUIREMENTS

The sight must be mounted on the aircraft so that its performance characteristics may be used most advantageously when the pilot sits in his normal working position. Its arrangement must also provide convenience for servicing and checking procedures.

Pay special attention to the following requirements:

(1) All sight units must be interconnected by cables in accordance with the sight cabling diagram (See Fig.126).

(2) All units and connecting cables in the metal shields must be reliably bonded to the aircraft structure.

(3) When the sight is mounted on the aircraft, the aircraft manufacturing plants should use the sight mounting set (See Chapter IX).

(4) The sight must be mounted on the aircraft to provide convenience for firing cannon and rocket weapons, as well as for bombing.

(5) The sight mounted on the aircraft should be supplied with 27 V $\pm$10% D.C.; 115 V $\pm$5%, 400 c.p.s. $\pm$5%.

(6) The sight should operate in conjunction with the attack and slip angles transmitter ДУАС and radar range finder or radar station.

(7) When mounting the sight set on the aircraft and when removing it for checking or repair, bear in mind that the sight head, computer, zero gyro, zero gyro amplifier, and control box of the set become not interchangeable after their adjustment. Other parts of the sights may be used interchange-

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ably (Assy 8 calling for adjustment of sensitivity and feed-back). Removable units for firing rockets are interchangeable. All units of the sight bear the same number.

2. SPECIAL REQUIREMENTS

(1) Sight head 2 (Fig.1) must be arranged in front of the pilot so that it does not obstruct the pilot's field of vision and so that the pilot may easily follow the movable reticle circle when firing rockets and shells, and dropping bombs. It should also ensure the convenient operation of the sight head controls and mode of operation selectors, Б-С, HP-30-PC, RADAR - OPTICAL arranged on the sight head bracket. The sight head must be arranged on special bracket 1 adjusting the sight head position relative to the aircraft axes.

The target and the sight movable reticle may be photographed by camera controller СШ-45. The bracket with the sight head should be arranged so that the head may be easily removed without the bracket, if necessary, as the sight setting is disturbed when the head is removed together with the bracket.

When removing the sight head from the bracket, be sure to disconnect the plug connectors ШР-1 and ШР-2 and the plug connector connecting the sight head and the range indicator on the bracket. When mounting the sight head on the bracket, join the plug connectors.

(2) Computer 3 must be mounted on the aircraft so that its dials may be photographed in flight and checked visually during ground tests.

(3) The zero gyro mounted on base plate 4 should be precisely oriented in respect to the aircraft axes in conformity with the designations marked on the zero gyro jacket. The zero gyro should be so mounted on the aircraft as to ensure its proper setting relative to the aircraft axes by the base plane on the zero gyro base plate and by the level provided on the base plate, with the following tolerance limits:

±45' relative to the aircraft vertical axis;
±30' relative to the aircraft lateral axis;
±30' relative to the aircraft longitudinal axis.

(4) Arrangement and mounting of zero gyro amplifier 5 on the aircraft must make the amplifier test connector accessible so that the fuse and electron valves may be replaced without removing the amplifier from the aircraft.

(5) Arrangement and mounting of control box 9 of the sight must provide easy access to the control box connector, fuses, radar ranging unit selector switch and replaceable ballistic unit.

(6) Static pressure must be fed to the pipe connection of altitude unit 8 from the aircraft static pressure receivers.

(7) Arrangement and mounting of voltage regulator CH-4 must be correct to ensure desired orientation relative to the direction of flight in accordance with the arrow marked on the jacket.

(8) The relay mounted on base plate 7 must be arranged on the aircraft within easy reach for ground checking and for replacement of the valves.

(9) Range manual introduction potentiometer must be arranged on the throttle control and its slider must be connected to the throttle control lever. The potentiometer slider should rotate to cover the range within 200 to 2000 metres.

3. SIGHT LAYING INSTRUCTIONS

The sight should be laid upon mounting it on the aircraft and checked for proper laying during routine checks.

To lay the sight:

(1) After placing the aircraft in the direction of flight, loosen the bolts securing the head bracket to the aircraft bracket. In this event, the sight head with the bracket can turn through certain angles relative to the aircraft axes.

(2) Switch on the sight.

(3) Unlock the sight head gyro by placing the locking lever against GYRO (ГИРО).

(4) Set selectors Б-С and HP-30-PC to positions C and HP-30 corresponding to the sight operation when firing cannon.

(5) Turn the throttle control lever to set 0.3 sec. in the computer scale T.

(6) Turning the bracket together with the sight head, point the sighting beam (sight reticle central pip) to the required spot on the testing target.

(7) Tighten the nuts of the pins securing the sight head bracket to the aircraft bracket and again check the sight laying. Mark the laying notches by paint.

Chapter II

MATCHING SIGHT АСП-5НД WITH UNITS PROVIDING FOR FIRE CONTROL PROBLEM SOLUTION

For solving the sighting problem the sight АСП-5НД receives target range data from the radar ranging unit or from the radar station.

The attack and slip angles, necessary to compute the aircraft slip correction for rockets, are introduced into the sight from the attack and slip angles transmitter - ДУАС. To ensure the correct and precise operation of the sight mechanisms, match the sight, radar ranging unit and ДУАС transmitter prior to (or during) mounting them on the aircraft.

1. MATCHING THE SIGHT WITH RADAR RANGING UNITS

Sight АСП-5НД may operate in conjunction with radar range finders СРД-5МК (КВАНТ) and also with radar stations.

To match the output characteristics of the radar ranging unit with the characteristics of the sight АСП-5НД proceed as follows:

(1) Connect the sight set with the radar ranging unit components according to the standard connection diagrams.

(2) Connect the tester to the radar ranging unit test connector. Prior to this the tester must be checked by calibration against angle reflector (See description of the radar ranging unit).

(3) Set the switch RADAR - OPTICAL on the sight head bracket to RADAR position, and the radar ranging unit type selectors in the control box and the computer - to the position complied with the type of the radar ranging unit employed.

(4) Switch on the sight and the radar ranging unit.

(5) Adjust the controls of the radar ranging unit tester to feed voltage for various ranges and check the range follow-up on the sight computer scale Д.

(6) If the range Д followed up on the sight scale differs from that set on the radar ranging unit tester, adjust the output voltages of the radar ranging unit. Tolerated error of the range followed up on the computer scale Д is within ±10m.

The outputs of the radars are matched with the sight characteristics just as in case of the radar ranging units, though cable P-1, switch RADAR - OPTICAL and lamp HIGH VOLTAGE ON are not operated.

2. MATCHING THE SIGHT WITH ДУАС TRANSMITTER

Sight АСП-5НД is designed to operate in conjunction with ДУАС-133-8 and ДУАС-8М. The employment of other types of ДУАС is possible provided that the measured angles, potentiometers resistance and matching circuits are kept within the permissible limits. To check the sight for proper matching with the attack and slip angles transmitter, make sure that when the horizontal vanes (α) are diflected upward, the sight reticle moves downward, and vice versa. When the vertical vanes (β) are deflected to the right (as viewed from the direction of flight), the sight reticle should move to the left, and vice versa.

The accuracy of the ДУАС mounting should comply with the drawing for the installation of the rod on the aircraft with tolerance ±17', the aircraft being levelled up.

The computed values of angles α and β should be within the limits, the maximum error not exceeding 25'.

The ДУАС operation is to be checked by a special device in accordance with the Instructions.

Chapter III

INSPECTION AND CHECKING OF SIGHT

The sight is to be checked-up and inspected in accordance with terms and regulations specified by the aircraft servicing procedure.

A. Outside Inspection of Sight on Aircraft

Inspect and check-up:

1. Armoured glass panels of the cockpit, light filter, reflector and objective for condition, reliable attachment, as well as for dust, dirt and oil spots. Clean the optical parts of the sight with a flannel cloth available in the sight maintenance kit. The sight reflector is to be gently wiped with a clean cloth moistened in alcohol.

Never clean the reflector in any other way to avoid the damage of the reflector coating.

2. The light filter is properly fixed both in the collapsed and operating positions.

3. The sight head is safety secured to its bracket and the sight head bracket - to the aircraft bracket. The notches applied during fire adjustment should be aligned.

4. The changeable ballistic unit in the control box corresponds to the type of the rocket employed.

5. Radar ranging unit type selectors in the control box and computer are set in compliance with the type of the radar ranging unit (or radar station) mounted on the given aircraft.

6. Inspect the ДУАС transmitter vanes. The vanes should not have any mechanical damages and should smoothly, without jamming, move from one extreme position to the other.

7. Inspect the sight units and wiring for proper condition.

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7. Inspect the sight units and wiring for proper condition.

B. Checking of Sight

To check-up the sight, switch it on and set the locking lever on the sight head at GYRO. By inspection and testing make sure that:

1. The sight reticle brightness changes from its maximum glow to going-out when the illumination rheostat knob is turned.

2. The throttle control lever connected with the range manual introduction potentiometer rotates easily and smoothly. In so doing:

(a) Computer scale Д moves within 2000 - 200 m.

When the range to the target reduces to 600 $^{+50}_{-20}$ m. the red lamp BREAK-OFF (ВЫХОД) should go on and continuously burn with the further decrease of the target range. In conditions of vibration and at low temperatures the lamp goes on at the target range of 600 $^{+80}_{-40}$ m.

(b) Computer scale T moves withing the time measuring limits for the given ballistic characteristics.

Perform the checking in positions НР-30 and РС.

(c) The pointer of the range indicator on the sight head should move withing 200 - 2000 m. range.

(d) Sight reticle circle increases with the decrease of the range (the base being set within 40 - 45 m.).

(e) When the range is changed from 200 - 2000 m., the sight reticle should come down computing the sighting angle.

3. The sight reticle circle diameter increases with the increase of the base and decreases with the decrease of the base, when the knob BASE (БАЗА) is turned.

4. When selectors Б-С, НР-30-РС, Н-ДУАС are set respectively to С, РС, ДУАС and when the ДУАС horizontal and vertical vanes are turning, the sight reticle should respectively move in the vertical and horizontal planes to compute the corrections for angles β and α.

5. Creating vacuum by set, type КПУ-3, make sure the altitude unit scale moves.

Having completed all the checks, lock the gyro and cut off the sight.

Chapter IV

COMBAT EMPLOYMENT OF SIGHT

1. SWITCHING PROCEDURE

1. 3 - 14 minutes before take-off, switch on the sight. (Turn on the HEATER and SIGHT switches).

2. Switch on the radar ranging unit. High voltage is applied to the radar ranging unit by setting the switch on the sight head bracket to RADAR.

3. If necessary, unlock the sight gyro after take-off by setting the locking lever on the sight head at GYRO.

4. Set the mode-of-operation selector HP-30-PC on the sight head bracket in accordance with the weapon to be used. The sight is ready for operation. For switching off the sight, first lock the sight head gyro by setting the sight head locking lever at FIXED (НЕПОД.), then turn off the switches SIGHT and HEATER.

Note: Never take off and land with the gyro unlocked (knob set at GYRO).

2. SIGHT OPERATING INSTRUCTIONS

During preparation of the sight for operation, bear in mind that the sight computes the angular corrections within the standard precision limits:

- in 3 minutes under normal conditions;
- in 10 minutes under $t = -40^{\circ}C$;
- in 14 minutes under $t = -60^{\circ}C$.

However, the sight can operate before the above time limits have expired.

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A. Attacks on Airborne Targets

When operating together with the radar ranging units, type СРД-5МК (КВАНТ), the sight АСП-5НД may be used for attacking the airborne targets at altitudes not lower than 600 m. The lower altitude limit depends on the radar ranging unit response threshold to signals reflected from the ground.

At lower altitudes or when the radar ranging unit fails, the sight outer base range finder should be used. When using the sight for firing rockets or shells, the sight mode-of-operation selector should be set to the position corresponding to the type of weapon fired. In this instance, the sight circuit is connected to compute the angular corrections for this particular weapon. Selector Н-ДУАС should be set to ДУАС.

Once a target has been detected, the fighter should take the attack position so that by the beginning of the sighting it may start the pursuit course under desired aspect angle and at desired range. The aspect angle and the range of the sighting initial point are determined by the zone of possible attacks which depends on the flight altitude, speeds of the fighter and target, ballistic characteristics of the weapons fired, radar ranging unit look-on range, and tactical considerations (arrangement and availability) of the weapons on the target, surprise of attack, position of the sun, and so on).

The fighter must approach the point where the sight starts tracking the target after the sight has roughly computed the correct angle of lead corresponding to the present firing conditions. This ensures the best operating conditions for the sight facilitating the further sighting and synchronizing processes and obtaining best fire effect at minimum synchronizing time and minimum period during which the attacking aircraft stays on the tracking curve. The period of attack is reduced by executing the manoeuvre resolutely, without losing time.

When the fighter turns in the direction opposite to the target movement, press the damping button to reduce the deflection of the sight reticle in the opposite direction thus reducing the time needed for resetting the angle of lead computed for sighting.

The button should be also pressed when the aircraft wings over (toward the target at high angular speeds).

While carrying out this manoeuvre, set the outer base range finder at a range approximately corresponding to the radar ranging unit reliable lock-on range so that the reticle oscillations in the sight field of vision are reduced to minimum when the target enters the radar ranging unit operation area, with the radar ranging unit looking on the target and with the sight being automatically changed over from the outer base range finder to the radar ranging unit.

<u>Note</u>: Before the lock-on lamp goes on, the sight is switched on to receive the range supplied by the range manual control, so the mobility of the reticle central pip and the sight reticle circle diameter are dependent on the range introduced into the sight manually. Therefore, the moment the target lock-on lamp goes on, the reticle central pip may jerk and the sight reticle circle diameter may change due to introduction of the true range measured by the radar ranging unit.

The range to the target during the attack is roughly estimated (accurate within $\pm$100 m. to $\pm$150 m.) by the readings of the range indicator mounted on the sight head bracket.

If the manoeuvre has been carried out correctly, the radar ranging unit must reliably look on the target at the beginning of the sighting process and the sight movable reticle must be pointed toward the target and deflected from the sight axis through the lead angle amounting to the rated value (in case the base set in the sight corresponds to the target size, the target is framed within the sight reticle circle).

While sighting, the pilot must keep the sight reticle central pip aligned with the target centre. The lead angle the sight has computed by the beginning of the sighting process must be corrected by synchronizing the movement of

the target with that of the sight reticle pip during 3 - 5 sec. after aligning the pip with the target.

The fire is started depending on the tactical situation.

To ensure effective firing results:

(1) Open fire only after having synchronized the movement of the target and the sight reticle central pip (3 - 5 sec.). During these three or five seconds, the radar ranging unit must reliably lock on and follow the target (the operation is controlled by the steady glow of the lock-on lamp, by gradual change of the sight reticle circle diameter, and by smooth travel of the pointer on the range indicator scale).

(2) Open fire only from ranges ensuring firing effects for the type of weapon employed. The range of the aimed fire is limited by the indicated time (T = 4 sec.) computed by the sight. The limitations are different for different types of weapons due to their different ballistic characteristics.

If the aimed fire is conducted on the ranges involving time that exceeds 4 seconds, the sight will compute the angular corrections for the range limited by T = 4 sec. and the sight reticle circle size may change from 8° to $1^{\circ}15'$.

(3) Do not open fire if the lead angles exceed 13°, with the electromagnetic limiter of the sight head gyro operating. The limiter operation is indicated by characteristic oscillations of the sight reticle at the sides of the field of vision.

When the target range reduces to 600 m., a red warning lamp on the sight head goes on warning the pilot of the necessity of break-off.

As was mentioned above, the sight sometimes receives the range supplied by the outer-base range manual control. In this instance, the sighting procedure differs from that when the range is introduced by the ranging unit in that the pilot must in addition keep the target framed within the variable diameter sight reticle circle by rotating the throttle control lever linked with the range manual introduction potentiometer through the gear train. The base introduced into the sight must correspond to the target size.

While framing the target with the sight reticle circle (the range being introduced either by the radar ranging unit or by the outer-base range manual control) bear in mind that the sight reticle circle changes its size from $1^{\circ}15'$ to 8° only for the combination of bases and ranges shown in Fig.2.

The chart in Fig.2 shows that the circle sizes within 8° to $1^{\circ}15'$ may be obtained only when the range and base values (Б and $Д_0$) stand within the operating zone. If these values go beyond this zone, the sight reticle circle follow-up mechanism reaches the limit stops and the circle diameter remains unchanged.

If the ДУАС transmitter fails, change over the sight to operate from the altitude unit by setting the selector on the sight head to Н .

The pilot may use the automatic sight as a mechanical sighting device when its automatic system fails. In this instance, the gyro locking lever on the sight head should be set at FIXED (НЕПОД.). The sight reticle circle diameter is set, depending on the firing conditions, by the knob BASE - CIRCLE (БАЗА - КОЛЬЦО) where the scale indications correspond to the circle radius in mils.

Prior to sighting, the pilot can obtain the required illumination intensity of the sight reticle in conformity with illumination intensity of the target and of the field of vision by rotating the reticle illimination rheostat knob on the sight head. When the background is illuminated brightly, the pilot may somewhat dim it by covering the field of vision with the light filter. The filter is brought to the required position by turning the light filter control knob on the sight head bracket. Prior to turning, the knob should be pulled out.

B. Attacks on Ground Targets

When firing at ground targets with shells and rockets С-5М, the sighting is performed in the same way as in case with the airborne targets without employment of the radar ranging

unit, but using optical range finder. When firing at ground targets with rockets С-5К, the sighting is carried out without measuring the target range as the values of T and $\alpha_{пр}$ for the ballistic characteristics of this rocket are computed by the sight as constant values. To perform the attack on the ground target the aircraft should take the preset position (altitude H = 1000 - 1500 m.; V = 400 - 500 km/hr). Having detected the target, the pilot depresses the damping button and begins diving at the angles of $\lambda = 20 - 35^{\circ}$, directing the sighting line upon the target. When the aircraft assumes the diving trajectory, the pilot releases the damping button and makes coarse laying of the central pip on the target. In the way of closing the target the pilot improves laying to make it fine.

There is no need to make allowance for the wind velocity as the pilot automatically (by turning the aircraft) introduces all the necessary corrections continuously aligning the sight reticle central pip with the target.

The sighting is to be performed smoothly with the time of pip-and-target synchronization being 3 - 5 sec. It is not advisable to correct small errors in laying at stable synchronization just before opening fire (when the error lies within the limits of 5 - 10 mils, which may be evident from the target size).

The sight reticle circle is used to determine the moment of opening fire. The firing range should be more than that set in the sight.

The target range set in the sight should comprise 0.75Д (of actual range of firing). The size of the reticle, corresponding to the actual range of firing, is set by changing "base" settings in the sight. For this purpose the base value equal to 0.75Б . (of the target actual base) should be introduced into the sight.

If the target size is unknown and the reticle circle can not be used to determine the moment of opening fire, the pilot should begin firing when the given range is reached (to be estimated by sight).

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C. Sight Operation at Bombing

Sight АСП-5НД enables to perform dive bombing in the simplest way.

1. Release bombs with the sight gyro being locked. Set selector Б-С on the sight head bracket to Б.

2. Turn the knob on the sight head to set the desired angle on the mirror tilting angle scale corresponding to the bombing conditions.

3. Bring the aircraft into a dive at the rated altitude, speed and sighting angle.

4. With the sighting line matched with the target and the rated altitude reached, press the release button.

Note: The aircraft should enter into a dive and start the bomb release under conditions similar to those of bombing with simple collimating sights.

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Chapter V

EMPLOYMENT OF SPT&A SET AND MAINTENANCE OF SIGHT

The spare parts, tools and accessories of the sight are used for routine maintenance operations, for replacement of parts that went unserviceable during operation and for maintaining the sight ready for employment.

The SPT&A set is placed into a wooden box, sealed by the sight Manufacturer. A list of articles placed into the box is glued to the box cover.

1. TOOLS

The routine maintenance operations and replacement of parts require the following tools (Fig.105):

2. ACCESSORIES

Accessories (Fig.109) of the SPT&A set for maintaining the sight serviceable include:

1. Canvas cover 3 intended to protect the sight head against dust, fouling and sun rays. While on the ground, it is removed for checking the sight only.

2. Flannel pieces 4 intended to remove dust from the sight optical parts. Grease and fouling are removed from these parts by cotton, slightly wetted in alcohol; then optical parts are wiped with a piece of flannel. Never touch the optical parts with fingers.

3. Oiler 5 with oil ОКБ 122-5 supplied for lubricating the gyro gimbal axles. Other grades of oil should not be used for lubrication.

4. Oiler 1 with oil ОКБ-122-7 supplied for lubrication helical gears of the sight head reduction unit.

5. Essential oil ampoules supplied for lubricating the potentiometer contact surfaces.

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6. Cambric tape 2 for cleaning the potentiometers.
7. Sandpaper 7 for cleaning the electric motor commutators.
8. Putty supplied for sealing cover-to-housing and objective-to-housing joints upon performing the routine maintenance operations.

3. SPARE PARTS

The spare parts furnished with the sight (Fig.110) include:

1. Twin triode 6Н12С .... 4 pcs
2. Twin triode 6Н1П .... 3 pcs
3. Kenotron 6Ц4П-В .... 2 pcs
4. Valve 13П1М (13П1С) .... 1 pc.
5. Lamp СМ-46, (27 V, 18 W) .... 4 pcs
6. Lamp СМ-37 .... 12 pcs
7. Lamp ТН-0.3 (holder 1Ш9-1) .... 1 pc.
8. Relay РП-7 РС 4521002 Сп .... 1 pc.
9. Relay РП-5 РС 4522009 Сп .... 1 pc.
10. Relay (Р9 – Assy 41) .... 2 pcs
11. Fuse ПК-30-1А .... 2 pcs
12. Fuse ПК-30-0.5А .... 4 pcs
13. Reflector 5НД-1-12 .... 1 pc.
14. Light filter 5Н-11-1 .... 1 pc.
15. Spring-loaded belt (3Н-1-184k) ...... 2 pcs
16. Brush for electric motor ДГ-4М ДГ-2 – Assy 11k) .... 4 pcs
17. Brush for electric motor ДГ-6 (ДГ-6 – Assy 15k) .... 4 pcs
18. Plate with brushes for electric motor ДР-3.5М (ДР-3.5М – Assy 8k).. 2 pcs
19. Changeable ballistic unit С-5k ...... 1 pc.

Valves 6Н12С, 6Н1П and 6Ц4П-В are intended for replacing blown-out valves of the zero gyro amplifier. For replacement of valves 6Н12С, remove the zero gyro amplifier cover with the clamps. When valves 6Н1П and 6Ц4П are replaced, the jacket is taken off, too.

Valves 6Н12С will be replaced with the valves taken from SPT&A set, attached to the given sight.

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Valves 6Н1П and 6Ц4П-В are furnished for replacement of blown-out valves of the electron relays. It is enough to remove the electron relay jacket for replacement of the valves.

Valves 13П1М are used for replacing blown-out valves of voltage regulator CH-4. To relace the valves, screw out four screws, securing the voltage regulator jacket, and remove the latter. After the replacement the voltage produced by regulator CH-4 should be checked by test equipment КП5СД.

Lamps CM-46 should be used to replace blown-out lamps illuminating the sight head. The replacement is easily done with the sight head rear cover open.

Lamps CM-37 are used to replace the sight head blown-out pilot lamps LOCK-ON (ЗАХВАТ) and OUT (ВЫХОД). When replacing the lamps, screw holders out of the sight head sockets.

Lamp TH-0.3 is used instead of the blown-out indicating lamp on the sight head bracket.

Relays of the РП-7 and РП-5 type are intended for replacing control box relays P_{30} and $P_{СИР}$. For replacement the jacket securing screws and the relay box jacket should be taken away.

Electron relay РЭ- Assy 41 is intended for replacing the above assembly of the sight electron relays. The relay is replaced after removing the electron relay jacket.

Safety fuse ПК-30-1А is used in the zero gyro amplifier instead of its blown-out fuse. Replacement of the safety fuse requires the removal of the fuse cap. Safety fuse ПК-30-0.5А is intended for replacement of the blown-out fuse in the control box.

The reflector and light filter of the SPT&A set are intended for the replacement of the damaged parts. To replace the light filter, remove six screws and retaining strips and detach the light filter from the bracket. The sight reflector is removed in the same way after taking the retaining strips away.

[redacted]

The reflector replaced and the sight head mounted on the bracket in the pilot's cockpit, the sight laying should be checked. If it is disturbed, the necessary adjustment is done by releasing the screws, securing the sight head bracket to the aircraft bracket.

The changeable ballistic units are installed in the control box in accordance with the type of the rocket employed. Unserviceable brushes of electric motors ДГ-4М, ДГ-6 and ДР-3.5М are to be replaced with the brushes of the SPT&A set in line with the procedure outlined in Chapter VI.

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Chapter VI

ROUTINE MAINTENANCE

The sight routine maintenance operations are performed in compliance with the Inspection Guide now in effect. To ensure the sight trouble-free functioning under various weather conditions (humidity, dust, etc.) as well as in case of sight intensive use, extraordinary maintenance operations may be performed in accordance with the Inspection Guide and Instructions given in the present Technical Description.

WARNING

When performing maintenance operations, the following precautions are to be observed:

(a) Do not turn the gyro by hand counter-clockwise (as viewed from the mirror side), as the electromagnetic limiter hair adjustment may be disturbed. When the electromagnetic limiter operating contact is broken, unbend the spare hair to have a gap between the mirror mounting and leather washer of the lock housing of 1.5 - 2 mm (at the moment the hair touches the electromagnetic limiter busbar). Check the gap size in four points.

(b) Check the motor gear for proper meshing with the brass gear of gear train Assy 1. The meshing should ensure a smooth and easy rotation. Perform the check with the side cover removed.

(c) When performing maintenance operations, be careful not to damage wiring.

(d) Having completed operations, apply putty to all joints of covers.

(e) Fit all attachment bolts on nitro-enamel.

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TECHNOLOGICAL INSTRUCTIONS ON ROUTINE MAINTENANCE OPERATIONS

A. Electric Motors ДГ-4М and ДГ-6

Normal operation of the electric motor requires the commutator to be regularly cleaned. To this end:

(1) Remove the sight head from the aircraft.

(2) Remove the jacket of the sight head front cover, after turning out six screws, securing the jacket to the front cover; put the screws into the jacket.

(3) Remove the sight head front cover by turning out four screws, securing the front cover to the sight head body. Set the looking lever at GYRO (ГИРО) and carefully take off the front cover.

The front cover is fitted on two round pins, therefore it is removed with some difficulty.

Arrange the front cover with the mirror looking up (place a sheet of clean paper on the mirror).

(4) Turn out three screws, securing the electric motor supply cable ends, and the screw, fixing the bonding wire to the housing.

(5) Turn out four screws, securing the electric motor to the front cover, and take the motor off.

(6) Remove the electric motor jacket after turning out four screws, securing the jacket to the housing; place the screws into the electric motor jacket.

(7) Take off the covers of brush holders 1 after turning out screws 2, securing the covers (Fig.111); put the screws into the electric motor jacket. Carefully take out the brushes with springs after marking the brushes and their holders so that they could be re-installed in the original position. Replace the brushes if their height is less that 4 mm or if they are asymmetrically worn out. Wipe the serviceable brushes with a gasoline-moistened cloth.

(8) Through the ports in the front shield, wipe the commutator with a wooden rod wrapped over with a clean piece

of cloth, slightly soaked in gasoline, turning the armature by hand. Check the condition of the commutator.

(9) In case the carbon deposit does not come off the commutator, use sandpaper No.320 (M-40) or M-28, M-20 folded up to form a narrow strip, which should be brought inside the electric motor, as far as the commutator permits, through the brush holder port.

Turning the electric motor armature by hand and pressing the sandpaper to the commutator, remove the carbon deposit. After that, blow the inside of the electric motor with compressed air through the ports in the front shield.

Put the brushes in place and protect them with the brush holder covers. Connect the motor to the 27 V mains and check its functioning. When replacing the brushes, lap them with the running electric motor for 1 hour prior to mounting the jacket. Clean the electric motor anew. The П - shaped contact with the soldered brush conductor should tightly fit the brush holes to ensure a reliable contact. Simultaneously check the cable, running from the contact to the brush, for continuity. The terminals of the П -shaped contact may be spread.

If the centrifugal regulator contacts are covered with carbon deposit, clean and wash them with alcohol. With contacts closed the gap between the contact movable plate and the free end of the adjusting plate should be at least 0.3 mm.

If this gap cannot be ensured, replace the motor.

Check the wires of the centrifugal regulator for safe soldering to the commutator segments.

Assemble and mount electric motor ДГ-4М (ДГ-6) in the reverse order.

When performing maintenance operations on motors ДГ-4М and ДГ-6, check the gyro mirror and plano-parallel plate for proper condition. Replace the mirror and plate, if their coating is damaged. Clean dirty surfaces with alcohol-ether mixture or with alcohol.

Install the front cover on the pins in the sight head and protect the cover by the jacket.

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B. Electric Motor ДР-3.5М

Normal operation of electric motor ДР-3.5М requires the commutator to be regularly cleaned. For cleaning:

(1) Open the sight computer by removing eight screws, securing the jacket to the computer plate.

(2) Unsolder wires, running from the electric motor to the adapter on the upper reversible clutch 2PT-200 noting the terminal the wire was soldered to.

(3) Turn out the screw, securing the attachment clamp of motor ДР-3.5М. Put the screws into the computer jacket. Remove the electric motor from the computer.

(4) Unscrew two screws, securing the cover with the brushes to the electric motor housing (Fig.109), and take the cover from the housing.

(5) Replace the brushes if their height is below 4 mm or if they are asymmetrically worn out. Wipe the serviceable brushes with a piece of cloth moistened in gasoline. To replace the brushes, remove two screws, securing the textolite ring with brushes, and two nuts, securing current-conducting leads to the brushes, remove assembly ДР-3.5М - Assy 8k. Take the spare assembly from the SPT&A set, wipe the brushes with a piece of cloth wetted in gasoline, and fit the assembly into the electric motor cover.

(6) Wipe the electric motor commutator with a wooden rod wrapped over with a clean piece of cloth (cambric, percale or silk), slightly moistened in gasoline.

(7) If the carbon deposit does not come off the commutator when wiped with a piece of cloth, use sandpaper No.320 (M-40) or M-28, M-20.

After removing the carbon deposit blow the electric motor housing and armature with compressed air.

(8) Prior to placing the cover into the electric motor housing, use the bracket, furnished with the SPT&A set, to force apart the brush holders. Insert the cover, use the pincers or watchmaker's screw-driver to disengage and remove the bracket from the brush holder through the hole in the motor housing (Fig.110).

The brushes replaced, switch on the electric motor for 1 hour to lap the brushes. Clean the electric motor anew.

(9) Install the electric motor in the computer in the reverse order, paying particular attention to the correct soldering of the wires (the electric motor should rotate counter-clockwise if viewed from the side of the output shaft) and to the proper meshing of the motor gear with the reduction unit gear (the meshing - at least 3/4 of the tooth height and the clearance between the gear teeth - 0.1 mm).

Note: Simultaneously with the inspection of motor ДР-3.5М check the limit switches of units Д and T. Check to see the moment when the electrical and mechanical limiters operate, bearing in mind that the electrical limiter should operate earlier than the mechanical one. In unit Д this difference in operation should be within two small divisions, while in unit T - not over one small division. If the contacts have carbon deposit, clean them and wash in alcohol. The contact pressure should be within the limits of 30 - 50 gr. If there is no grammeter, check pressure as follows: slightly depress the end of the prolonged contact plate in the direction of opening contacts to see that the second plate slightly moves in the same direction.

If the contact pressure is less than specified, bend the spring-loaded contact to make the pressure normal.

Take care not to change the difference in operation of the electrical and mechanical limiters.

C. Lubrication of Sight Head Gyro Universal Joint Axles and Central Bearing

To lubricate larger and smaller axles of the sight head gyro universal joint proceed as follows:

(1) Remove the jacket of the front cover and the front cover.

(2) Arrange the front cover as shown in Fig.111.

(3) Apply lubricant ОКБ-122-5 to a thin needle.

(4) Insert the lubricant-coated needle into the port on the gyro dome against the larger axles (Fig.111).

(5) Turn the gyro to make the gyro dome ports accessible for lubricating the small axles.

(6) Put the lubricant-coated needle into the aforesaid ports (Fig.111).

[redacted]

(7) To make lubricant ОКБ-122-5 get into the gyro universal joint axle bearings, bringing the gyro unit mirror down, switch on the gyro electric motor and let the gyro spin within 10 - 15 seconds, feeding +27 V and -27 V to pins 5' and 11' of connector ПГ-1, respectively (wires 003 and 6, disconnected when the cover was removed, are to be preliminarily connected).

Turn the gyro so that the mirror is in front of the operator and by the needle introduce lubricant ОКБ-122-5 into the port, made on the race of the central bearing, through the slot in the electromagnetic limiter current-carrying busbar.

When lubricating the gyro universal joint and the central bearing, be most careful to keep lubricant off the electromagnetic limiter busbar and wires. If traces of lubricant are detected, thoroughly remove them with pure gasoline, taking care not to disturb the wire bending angle and the position of the busbar. Work done, check the mirror and the plano-parallel plate for proper condition. Wash the dirty surface with alcohol or ether alcohol.

D. Lubrication of Zero Gyro Universal Joint Axles and Central Bearing

Set the zero gyro with the inductive transmitter facing upwards.

Use wire, 0.5 - 0.8 mm in diameter, to introduce through the port in the centre of the inductive transmitter armature (Fig.113) two - three drops of oil ОКБ-122-5 to lubricate the zero gyro universal joint bearings and through one of the inclined ports in the armature framing (mirror) - three - five drops of oil to lubricate the central bearing. Rotate the armature framing for the uniform oiling of bearings.

Chapter VII

INSTRUCTIONS ON SIGHT OPERATION AND MAINTENANCE

1. When the sight is employed under conditions of great humidity, the inner surfaces of the sight head optics may become dimmed (with the tumbler HEATER (ОБОГРЕВ) switched on), which does not disappear upon the setup time. In this event heat the sight head until the optics is free from sweating. To avoid sweating regularly (twice or once a month) switch on the tumbler HEATER for 40 - 60 minutes.

2. To obviate the residual strain of the limit switch springs in the computer and altitude mechanism Д and T units, do not keep the scales in the extreme positions.

3. When the sight remains inoperative for a long time (more than a month), regularly switch on the sight for operation so that the computer functions for 5 minutes, following up the values within the whole range.

4. Replace the illumination lamp if its inner surface becomes dark. After the replacement adjust the lamp holder position in the vertical and horizontal planes to obtain the maximum brightness of the reticle.

To avoid an early failure of the illumination lamps, make sure that the reticle illumination is cut off after the sight has been switched off. (Turn the illumination rheostat knob to OFF). Switch on the reticle illumination by operating the rheostat knob after cutting in the sight.

The reticle illumination lamp should tightly fit its holder. Otherwise, the holder should be tightened (near the bayonet grooves).

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5. When not used, the sight head should be covered by a slip-case to protect the optics against dust and humidity penetration.

6. Periodically interrogate pilots to make sure that in flight the reticle is not "blurred" when the lead angles are constructed. The gyro is considered to be faulty and needs repair if the reticle central pip gets the appearance of a certain circle with a dark point in the centre. The checking is to be carried out at R = 2000 m. (manually introduced on the range indicator) and at angular velocities, ensuring the sight reticle deflection through 8 – 10° (till the electromagnetic limiter operates).

On the ground the reticle is checked for blurring at R = 2000 m. The sight reticle central pip should not increase when the sight is changed over from FIXED (НЕПОД.) to GYRO (ГИРО).

7. When inspecting the sight, check the reserve run of the microswitch rod, which is performed by a smooth shifting of the lock lever from FIXED (НЕПОД.) to GYRO (ГИРО). After the microswitch operates, the rod must cover 0.25 – 0.5 mm.

Adjust the limit switch position if there is no reserve run.

8. Patches of light (in the form of the reticle image), which do not hinder observation, are allowed in the sight field of vision. (At the lesser illumination of the reticle the patches of light disappear, the reticle circle remaining well visible).

9. If the sight was kept in stores for a long period of time (two years or more), check its motors ДР-3.5М, ДГ-4М, ДГ-6, for proper conditon and lubricate the bearings of the main and zero gyros before mounting the sight on the aircraft.

If equipment РКП-5 or board 5НД-У of the training operating or training cut-away set of sight АСП-5НД is available, it is allowed to check the sight operation within the scope, prescribed for the sight inspection with the employement of testing equipment КП5СД.

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10. Replacement of Sight Head Gyro Spring-Loaded Belt

To replace the belt, proceed as follows:

(a) Remove the front cover.

(b) Undo one screw to remove the intermediate roller.

(c) Remove the faulty belt.

(d) Remove excessive lubricant from the spare belt.

(e) Fit the spring-loaded belt on the pulleys of the gyro universal joint and electric motor so that the cone of the joint (lock) runs on the pulley grooves while rotating (Fig.114).

The belt lock position adjusted and the front cover set with the mirror upwards, fit the belt over the mirror mount so that the belt should fall behind it.

(f) Pull the belt out through the lock holder hole by the pincers and pass it over the electric motor pulley. Tighten the belt carefully, to avoid residual strain.

(g) Reinstall the intermediate roller and pass the spring-loaded belt through its grooves.

(h) Make sure that the belt is in the grooves of the electric motor and gyro pulleys and on the intermediate roller.

11. Washing of Computer and Altitude Unit Potentiometers

During the operation of the sight the working tracks of the computer and altitude unit potentiometers may happen to be dirty, which results in the uneven follow-up of the Д and T scales, reticle circle diameter, elevation angles, etc. In some portions sudden kicks to the maximum or minimum values are possible.

To eliminate the aforesaid malfunctions, it is necessary to wash the working tracks of all computer and altitude unit potentiometers with ether alcohol (80 per cent of ethyl ether and 20 per cent of alcohol).

After washing, coat the working tracks with a thin layer of essential oil H-731 using a rod with a piece of cloth.

A. <u>Washing of Computer Potentiometers</u>

1. Remove the unit from the aircraft.

2. Unscrew the attachment screws and remove the upper jacket.

3. Turn out four screws 3 (Fig.115), securing the twin package of adjustable resistors 4. Without removing two upper screws 3 from the holes of the adjustable resistor package carefully bring the resistors with wires aside, providing a better access to the range and time units Д and T.

4. Take a stick, wrapped in cambric, wetted in ether alcohol, and through holes 2 in the scales wash the working tracks of potentiometers $П_{11}$, $П_5$, $П_4$, $П_{16}$, $П_{17}$ in unit Д and $П_1$, $П_7$, $П_9$, $П_8$ and $П_{26}$ in unit T. The potentiometers are arranged in the above order from the periphery to the centre.

5. Clean the potentiometers carefully so as not to impair the brush contact pressure, not to damage the unit wiring and not to leave cambric hairs on the potentiometer working tracks. Change the position of the movable brushes turning the gear manually to actuate the gear train so that the whole working surface of the potentiometers should be properly cleaned.

6. After washing, check whether the contacts are reliable. For this purpose, connect tester TT-1 (or any resistance measuring instrument) to the circuits and, shifting the brushes from one extreme position to the other, check the resistance variation, consulting the tables below. The resistance should gradually change. If the resistance changes by jerks on certain sections of the track, clean the appropriate potentiometer again and repeat the check-up.

The table below gives approximate values of the potentiometer resistance.

Table for Time Unit

Nos	Potentiometer	Terminals of current-conducting springs	Terminals of distributing block on unit T with numbered wires	R_{min} (ohm)	R_{max} (ohm)
1	$П_1$	Б	19	50	1500
2	$П_7$	Г	82	10	160
3	$П_9$	Е	79	25	900
4	$П_8$	К	69	25	900
5	$П_{26}$	Л	172	1	300

Table for Range Unit

Nos	Potentiometer	Terminals of current-conducting springs	Terminals of distributing block on unit Д with numbered wires	R_{min} (ohm)	R_{max} (ohm)
1	$П_{11}$	Б	165	300	12,000
2	$П_5$	Г	47р	15	750
3	$П_4$	Е	47н	15	750
4	$П_{16}$	К	3	58	1800
5	$П_{17}$	Л	06	8	250

7. Install the adjustable resistor package and lock it by screws. Check whether the wires running to the adjustable resistors are arranged properly. The wires should not contact the scales and movable parts of the units or rub against them.

8. Protect the computer by the jacket. Seal the jacket-to-housing joint with putty.

9. Connect the unit to the set and check the operation of the instrument.

10. Mount the computer on the aircraft.

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B. Washing of Altitude Unit Potentiometers

1. Remove the unit from the aircraft.
2. Turn out four screws and remove the jacket.
3. Tightly wrap cambric round a stick, wet it in ether alcohol and clean the working tracks of potentiometers $П_2$, $П_3$ and $П_{19}$ (potentiometers are shown from the periphery to the centre (See Fig.120).

To clean the potentiometer working tracks under the brushes, use vacuum set КПУ-3 and proceed as follows:

(a) apply 115 V, 400 c.p.s. to terminals 9 and 10 of connector H;

(b) shift the altitude unit potentiometer brushes by means of the КПУ-3 vacuum set;

(c) clean the potentiometer working tracks that were under the brushes.

4. The cleaning done, check whether the contacts are reliable. For this purpose connect tester TT-1 (or other instrument for measuring resistance) to the contacts of connector H according to the table given below.

Table for Altitude Unit

No.	Potentiometer under test	Contacts of connector H
1	$П_2$	3' - 12'
2	$П_3$	3' - 13'
3	$П_{19}$	6' - 14'

Operating КПУ-3, change the altitude from 500 m. to 25,000 m. The potentiometer resistance should gradually change.

5. Make sure the cleaning has been done properly and install the jacket in place.

Seal the jacket-to-housing circular joint with putty.

6. Mount the altitude unit on the aircraft.

Note: Never shift the brushes by hand without connecting the vacuum unit as it brings about complete maladjustment of the unit.

Clean the potentiometers with due care, protecting the potentiometers against damage and the brush contact pressure-against maladjustment. Check to see that after the cleaning the potentiometer working tracks are free from cambric hairs.

Replacement of Assy 41 with Spare Assembly of Individual SPT&A Set

Sometimes the replacement of Assy 41 brings about oscillations of the computer scales (riticle circle plano-parallel plate) about the value that has been followed up or a constant error. To remove the above defects, adjust the electron relay of the appropriate channel and check the precision of the parameters followed up by means of testing equipment КП5СД.

Note: When the sight operates in cojunction with the ДУАС transmitter, the plano-parallel plate (ППП) follows up the angles intermittently, which may cause the reticle to oscillate within ±7' in the vertical plane; it is a peculiarity of the follow-up system with an electrical filter.

Replacement Procedure

1. Make sure that the voltages and frequency of the A.C. and D.C. power sources meet the standard requirements (27 V ±10% ; 115 V ±5%).

2. Determine the faulty channel of the electron relay (Д, Т, reticle circle, or plano-parallel plate).

3. Remove the faulty unit and disconnect the cables.

4. Remove the jacket from the electron relay and replace Assy 41 of the appropriate channel.

5. Adjust the electron relay, if after the replacement of Assy 41 the computer scales (reticle circle, plano-parallel plate) oscillate or a constant error appears.

Check of Electron Relay Sensitivity

(a) Check the sensitivity of the computer electron relay channels by the follow-up precision of scales Д and Т, employing control board КП5СМ-3 of test equipment КП5СД For checking set the range knob to 400-m.reading bringing

the knob first from smaller and then from greater values. If the indications of scales Д and T differ by less than 1/2 smaller division of the respective scales, the sensitivity of the electron relay is adequate. In this check-up a constant error is liable to appear due to drift of zero. The elimination of the error is dealt with below. Following the same procedure, check the sensitivity at 1000-m. range and 1600-m. range, setting the switch on control board КП5СМ-3 to the respective positions from the sides of smaller and greater values.

(b) The sensitivity of the sight reticle circle follow-up relay is considered to be sufficient, if the circle diameter noticeably changes, when range knob Д on board КП5СМ-3 is set against 1000 m. and the BASE КП5СМ-3knob is turned through one or two divisions within a range of 40 ±2 m.

(c) The sensitivity of the plano-parallel plate follow-up relay is considered to be satisfactory, provided that with selectors Н-ДУАС, НР-30-РС set to H and PC positions, the plano-parallel plate does not oscillate and the difference in readings of following-up the plano-parallel plate from one side and from the other to the set position is within 10'.

Adjustment of Electron Relay

If necessary, the sensitivity of the electron relay may be improved by rotating the axles of potentiometers R_2 and R_{20} clockwise (See table below).

Table

Assy	What is followed up	Parts, related to		Adjustment elements		
		this channel only	both channels	sensitivity regulator	feed-back	zero setting
Computer Assy 42	Д	Assy 41 (extreme) 6Н1П(Л$_3$)	6Н1П(Л$_1$)	R_{20}	R_{31} (in computer)	R_{13}
	T	Assy 41 (inner) 6Н1П(Л$_2$)	6Ц4П(Л$_4$)	R_2	R_{32} (in computer)	R_{12}

1	2	3	4	5	6	7
Electron relay Assy 8	Reticle circle diameter	Assy 41 (inner) 6Н1П($Л_2$)	6Н1П($Л_1$)	R_2	R_{31} (in electron relay)	R_{12}
	Plano-parallel plate	Assy 41 (extreme) 6Н1П($Л_3$)	6Ц4П($Л_4$)	R_{20}	-	R_{13}

Adjustment of Electron Relay "Zero"

If upon replacement of Assy 41 a constant error accompanies the follow-up of Д, T and the sight reticle circle, though the electron relay sensitivity remains satisfactory, adjust R_{12} and R_{13} (See the Table) to bring the parameters in question to the rated values given in the test tables.

The deviation of the plano-parallel plate "zero" may be checked as follows:

Use the knob of angles to set the plano-parallel plate to the middle position and remove the ballistic unit from the sockets of the control box (selector HP-30-PC is in PC).

If the plano-parallel plate starts moving to an extreme position, eliminate the "zero" deviation in the plano-parallel plate channel by adjusting R_{13}.

Removal of Oscillations of Scales Д and T, Reticle Circle or Plano-Parallel Plate

If oscillations of scales Д and T or of the reticle circle appear, adjust the tachogenerator feedback value by adjustable resistors R_{31} and R_{32} and reduce the sensitivity of respective channels by rotating the axles of variable resistors R_2 and R_{20} counter-clockwise.

The oscillations of the plano-parallel plate are eliminated only by rotating the axle of variable resistor R_{20} counter-clockwise.

This done, check the follow-up precision of the computer scales, reticle circle diameter or plano-parallel plate angles (depending on the channel adjusted).

After adjustment, lock the axles of variable resistors R_2 and R_{20} by tightening the locking nuts. Coat the adjustment screws with nitro-enamel.

Chapter VIII

TEST EQUIPMENT КП5СД FOR CHECKING SIGHT АСП-5НД

The set of equipment КП5СД is intended to check sight АСП-5НД, but it may be also used for checking sight АСП-5Н.

1. MAIN DATA ON КП5СД EQUIPMENT

The set of equipment КП5СД is intended to check the sight on the aircraft as well as in laboratories.

The set of test equipment КП5СД includes:

1. Electric power panel КП5СМ-3.
2. Electric power panel КП5НД.
3. Optical unit КП5С-2.
4. Tools and accessories set.

Panel КП5СМ-3 (Fig.117) is used as a simulator of СРД-5 (Base-6) for checking bridge Д and computing circuits of sight АСП-5НД. Besides, it serves to:

(a) check the current in heater, prediction and sighting circuits;

(b) measure 115 V, 22 V, 27 V and reference voltage fed by the radar ranging unit;

(c) measure the gyro precession time (in conjunction with panel КП5НД and optical unit КП5С-2);

(d) control the main gyro by means of the zero gyro (in the horizontal plane).

Control board КП5НД (Fig.118) functions as a ДУАС simulator. It may introduce values of angles of attack α and slip angles β. The checking is performed in cojunction with panel КП5СМ-3.

Optical unit КП5С-2(Fig.119) serves for checking the gyro deflection angles and the sight reticle circle diameters.

The optical unit is screwed directly to the sight head housing on the ribs of the rear cover.

The test equipment is not furnished with the sight set and is delivered to a special order.

The construction and purpose of separate units of the test equipment set are given in detail in the description of test equipment КП5СД, furnished with each set.

Test equipment КП5СД provides for checking the following parameters of sight АСП-5НД:

1. Supply voltages:

(a) 27 V ±10%, D.C;

(b) 22 ±0.3 V (stabilized voltage);

(c) 115 V ±5%, 400 c.p.s. , A.C. (check A.C. voltage with the radar ranging unit on);

(d) the radar ranging unit reference voltage supplied to the range follow-up bridge.

2. Checking the current in the heater circuits of the main and zero gyros and of the optics.

3. Checking the precision of the range follow-up on the sight computer scale.

4. Checking range indicator readings.

5. Checking the precision of the time follow-up on the sight computer scale.

6. Checking the computing precision of elevation angles for the cannon and total corrections for attack, slip and elevation angles for rockets.

7. Checking time constant τ of the ДУАС filter.

8. Checking the plotting precision of the sight reticle circle diameters.

9. Checking the main and zero gyro circuits.

10. Checking the current in the sighting circuit.

11. Checking the airtightness and operation of the altitude unit.

In case of any fault in the sight, the checking is to be carried out with due account of malfunctions in sight operation.

The checkings to be performed, when the sight is malfunctioning, are described in the List of Possible Troubles (See Appendix No.1).

When operating panel КП5СМ-3, general regulations for electric meters operation are to be observed. (When taking off readings, the panel should be in the horizontal position; protect the panel against shocks; adjust zero by the mechanical correction unit; timely check instruments М-45М and ПМ-70 for precise operation).

2. CHECK OF SIGHT WITH TEST EQUIPMENT SET КП5СД

To check the aircraft automatic sight with the test equipment set, proceed as follows:

1. Remove caps from monitoring connectors КУ of the control box and УНГ of the sight zero gyroscope amplifier.
2. Connect electric power panel КП5НД to the control box reference connector. Connect electric power panel КП5СМ-3 to panel КП5НД through cable КУ-УНГ. One end of cable КУ should be coupled with electric power panel КП5НД the other one - with the reference connector of the zero gyroscope amplifier. For connection diagrams of the panels see Figs 120 and 121.
3. Place and secure optical unit КП5С-2 on the sight.
4. Attach a special head to the aircraft air speed tube. By means of a vacuum rubber hose(to be taken from the SPT&A set) connect the head with vacuum set КПУ-3, designed for testing speed and altitude instruments.

If the sight is to be tested in a laboratory, connect the vacuum set with the pipe union of the sight altitude mechanism through the rubber hose.

Check of Sight Supply Voltage

To measure the 22 V D.C., 27 V D.C. and 115 V A.C. place MEASURING (ИЗМЕРЕНИЕ) knob 3 on panel КП5СМ-3 in the 22 V, 27 V, 115 V positions respectively.

The 22 V and 27 V voltages should be measured on the 30 V scale, the 115 V A.C. voltage is to be measured on the 150 V scale; in both cases 115 V - ON (115 В - ВКЛ.) switch 14 should be in the ON (ВКЛ.) position. The presence of the reference

voltage of the radar ranging unit is checked on the 300 V scale.

Check of Heater Circuits

To check the heater circuits of the sight, proceed as follows:

1. Switch on the sight.

2. Place MEASURING knob 3 on panel КП5СМ-3 in the HEATING (ОБОГРЕВ) position. The currents of the gyroscopes and optics heaters should be measured separately. To measure the current, place switch GYRO (ГИРО) 5 or OPTICS (ОПТ.) 6 in the MEASURING position.

CAUTION: Never place the ZERO GYROSCOPE (НГ) switch 4 in the MEASURING position!

The current in the heater circuits will be measured with instrument M-45M, its scale ranging up to 7.5 A. The total current of the main and zero gyroscopes heaters should be about 5.3 A, provided the voltage is 27 V and the gyroscopes are not warmed up. To avoid the overheating of the instrument M-45M shunt, switch on the GYRO switch for not over 1 min.

The optics heater circuit current should be within 0.17 - 0.3 A at 27 V.

Check of Range Presentation Accuracy on Sight Computer Scale and Range Indicator

To check the range presentation accuracy, compare the readings on the computer range scale with the range value, set on panel КП5СМ-3, as follows:

1. Place СРД-5 switch 10 in the positions, corresponding to the position of the radar ranging unit type switch ПКР-1 mounted in the control box and of the ПКР-2 switch, mounted in the computer.

2. Place INSTRUMENT - PANEL (ПРИБОР-ЩИТОК) switch 8 in the PANEL (ЩИТОК) position.

3. Switch on the sight. Set the lock knob in the GYRO position.

4. Change the range by turning the RANGE (Д) switch on panel КП5СМ-3 to make sure that the range, set on the panel is

accurately (within ±10 m.) followed-up on the sight computer range scale.

The accuracy of the range indicator presentation is checked simultaneously. The range indicator may be also checked by manually setting the range as follows: place the RADAR - OPTICAL (РАДИО - ОПТ.) switch on the sight head bracket in the OPTICAL (ОПТ.) position and the INSTRUMENT - PANEL switch on panel КП5СМ-3 in the INSTRUMENT position. The range accuracy of the indicator as compared with the readings of the computer range scale is ±100 m. for a distance of up to 800 m. and ±150 m. for a distance exceeding 800 m.

Check of Sight for Proper Following-up of Time T

To check the sight for the following-up of time, proceed as follows:

1. Switch on the sight, uncage the head gyroscope.
2. Set an altitude of 2000 m. on the altitude unit by means of vacuum set КПУ-3.
3. Set the sight switches BOMB - SHELL/ROCKET (Б - С) and HP-30 CANNON - ROCKET (НР-30-РС) in the positions, corresponding to weapon under check, and install the proper changeable unit in the control box. Set required ranges by means of panel КП5СМ-3 or manual setting knob and compare the time followed-up on the time scale of the computer with the values specified in Table 1, Appendix 2.
4. Perform the similar check at a height of 7000 m.

Check of Elevation Angles for Cannons and Attack, Slip and Elevation Total Angular Corrections for Rockets

1. Set I CONTROL (I УПР.) and I SIGHT (I ПРИЦ.) switches 12, 13 on panel КП5СМ-3 in the ON (ВКЛ.) and PRECESSION (ПРЕЦЕССИЯ) positions respectively; place MEASURING switch 3 in the I VERTICAL (1 В) position.
2. Switch on the sight, uncage the head gyroscope, place the BOMB - SHELL/ROCKET and HP-30 CANNON - ROCKET switches in the SHELL/ROCKET and HP-30 CANNON positions respectively. By

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means of the manual range setting set time $T = 1$ sec. on the computer scale. The INSTRUMENT - PANEL switch 8 should be in the INSTRUMENT position. Turn adjusting screws of the optical unit to bring its crosshairs against the sight reticle central pip.

Cage the gyroscope and check it for catch accuracy which should be within ± 10.

3. Turn on I SIGHT switch 13 on panel КП5СМ-3. Set 115 V. ON switch 14 in the 115 V position and uncage the head gyroscope.

4. Set an altitude of 7000 m. on the sight altitude unit by means vacuum set КПУ-3.

Set the required ranges by the manual range setting or radar ranging unit simulator (in this case set the INSTRUMENT - PANEL and RADAR - OPTICS switches in the PANEL and RADAR positions respectively) and check elevation angle values against Table 2.

5. To check attack, slip and elevation angles total corrections for rockets, place the НР-30 CANNON - ROCKET and Н - ATTACK AND SLIP ANGLES TRANSMITTER (Н - ДУАС) on the sight head bracket in the ROCKET and ATTACK AND SLIP ANGLES TRANSMITTER (ДУАС) positions respectively. Set time values by the manual range setting, the INSTRUMENT - PANEL and RADAR - OPTICS switches of panel КП5СМ-3 being placed in the PANEL and OPTICS positions respectively.

To check the vertical component of an attack and elevation angles correction, set $\alpha - \beta$, α, $\beta - \tau$, PRECESSION (ПРЕЦЕССИЯ) switches 3, 4 on panel КП5НД in the α and $\alpha - \beta$ positions respectively. Use the attack and slip angles transmitter simulator, mounted in panel КП5НД, to set values of angle α. Check the elevation angles followed-up by the sight against Table 3.

To check the horizontal component of the slip angle correction, set the $\alpha - \beta$ switch on panel КП5НД in the β position and I SIGHT switch 13 on panel КП5СМ-3 - in the PRECESSION position. Set values of angle β by the simulator, placed in panel КП5НД. Check the train angles followed-up by the sight against Table 4. When positive values $+\beta$ are introduced, the

sight reticle should deflect to the right; when negative values $-\beta$ are introduced, the sight reticle is to deflect to the left. Optical unit КП5С-2 mounted on the sight head is used to read off the angles followed-up. Keep in mind that the optical unit gives an inverted image.

To measure angles exceeding 5°, displace zero (the optical unit crosshairs), which makes it possible to measure wider angles.

When checking the vertical component of the attack and elevation angles correction for rockets in the altitude unit mode of operation, set the H – ATTACK AND SLIP ANGLES TRANSMITTER switch on the sight head bracket in the H position.

All other switches should be set in the positions, prescribed for checking the vertical component of the attack and elevation angles correction in the attack and slip angles transmitter mode of operation.

Altitude is to be set by means of installation КПУ-3. Check the angles followed-up by the sight against Table 5.

Check of Time Constant τ of Attack and Slip Angles Transmitter Filter

To check the time constant of the filter, connected to the attack and slip angles transmitter circuit, set all switches on the panels and instrument in positions, prescribed for checking the vertical component of the attack and elevation angles correction for rockets. Set angle of attack $\alpha = 0$ by means of the wafer switch on panel КП5НД. On the reticle of optical unit КП5С-2 measure computed angle ϕ_1 (for instance, $\phi_1 = 10'$). Set the α, $\beta - \tau$, PRECESSION switch in the τ, PRECESSION position and measure angle ϕ_2 (for instance, $\phi_2 = 2^{\circ}40'$).

Find angle ϕ_3 by formula $(\phi_2 - \phi_1)\cdot 0.63 = \phi_3 =$

$$= (2^{\circ}40' - 10')\cdot 0.63 = 1^{\circ}34'$$

Time for the sight reticle to pass the value of angle ϕ_3 from angle ϕ_1 (in the above example – from $10'$ to $1^{\circ}44'$) is equal to τ. Start the stopwatch and change over the switch

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from the α, β to the τ, PRECESSION position simultaneously. Make 3 - 5 measurements of τ and take the mean value $\tau = 4.8^{+0.8}_{-0.2}$ sec.

Check of Reticle Circle Diameter Precision

To measure the precision of the reticle circle, proceed as follows:

1. Set the HP-30 CANNON - ROCKET and BOMB - SHELL/ROCKET switches on the sight head bracket in the HP-30 CANNON and SHELL/ROCKET positions.
2. Switch on the sight.
3. Uncage the head gyroscope.
4. Change the range value manually and make sure that with the range increasing the reticle circle diameter is decreasing and vice versa.

By setting the base (with the base switch on the sight head) and required range (by means of panel КП5СМ-3 or manually), check the reticle circle size according to Table 6.

Measure the size along the inner circumference of the circle.

5. Cage the gyroscope; change the circle diameter by turning the base switches to measure the circle size according to Table 7.

Note: For the sake of convenience match the optical unit crosshairs with the sight reticle central pip.

Check of Main and Zero Gyroscopes Circuits

This test is intended for measuring the head gyroscope prediction current, checking the availability of the sighting current and zero currents in the correction coils of the zero gyroscope, drift of the main gyroscope when currents change in the zero gyroscope horizontal coils and for checking the head gyroscope gimbals for friction (by the time of the gyroscope precession).

(a) Check of Head Gyroscope Prediction Current

1. Set the BOMB - SHELL/ROCKET and HP-30 CANNON - ROCKET switches on the sight head bracket in the SHELL/ROCKET AND HP-30 CANNON positions respectivley.

2. Switch on the sight, uncage the gyroscope.

3. Set MEASURING switch 3 in the I Y position.

4. Set I CONTROL switch 12 on panel КП5СМ-3 in the ON position and measure currents in the prediction circuit, while changing the range manually within 2000 - 200 m. The current should vary from 90 to 400 mA.

(b) Check of Sighting Current

Set MEASURING switch 3 in the I CONTROL position, I SIGHT and I CONTROL switches 13, 12 - to ON, 115 V switch 14 - in the 115 V position and check the sighting circuit for presence of current by milliammeter ПМ-70. The sight reticle does not deflect within the field of view because the vertical channel correction circuit is broken.

(c) Check of Main Gyroscope Drift by Changing Current in Zero Gyroscope Horizontal Coils

To check the master gyroscope drift, proceed as follows:

1. Set the HP-30 CANNON - ROCKET switch on the sight head bracket in the HP-30 CANNON position.

2. Switch on the sight, uncage the head gyroscope and set a range of 2000 m.manually.

3. Set I SIGHT switch 13 on panel КП5СМ-3 in the PRECESSION position and I CONTROL and 115 V switches 12, 14 - to ON.

4. Place the α - β and α, β - τ, PRECESSION switches on panel КП5НД in the β and τ, PRECESSION positions, respectively.

5. Set MEASURING switch 3 in the I GROUP (I ГР.) position and change the value and direction of current with switch 15, to check the reticle image deflection in the horizontal plane through optical unit КП5С-2 mounted on the sight head.

When the current direction changes, the direction of the sight reticle image deflection should also change.

(d) Check of Head Gyroscope Precession Time

The gyroscope precession time is determined by the time the sight reticle central pip returns from an angle of $4^{\circ}30'$

to an angle of 1°. To check the precession time, shift the sight reticle central pip at an angle of about $4^{\circ}30'$ (See Item "c").

Place I CONTROL switch 12 on panel KП5CM-3 in the PRECESSION position and measure the time necessary for the sight reticle central pip to return from an angle of $4^{\circ}30'$ to an angle of 1° (use a stopwatch for the purpose).

The precession time should be at least 30 sec.

Perform this check, shifting the reticle image in both directions. While measuring the precession time, do not keep the sight reticle in the extreme position for long periods.

<u>Note</u>: Checks specified under Items "c" and "d" should be performed only with changeable ballistic unit C-5M mounted in the control box.

(e) Check of Zero Currents in Zero Gyroscope Correction Coils

Zero current is a current available when the zero gyroscope is in the zero (without drift) position without angular velocity.

The vertical and horizontal channels of the zero gyroscope should be checked separately.

To check the zero current of the zero gyroscope correction horizontal channel, switch on the sight, uncage the head gyroscope, place MEASURING switch 3 on panel KП5CM-3 in the I HORIZONTAL (I Г) position. The correction horizontal channel current should not be more than 3 mA. 115 V, I SIGHT and I CONTROL switches 14, 13, 12 must be placed to ON, when checking the current.

To check the zero current in the vertical channel of the zero gyroscope correction, place MEASURING switch 3 to the I VERTICAL (I B) position. The I SIGHT, I CONTROL switches being placed to ON and the 115 V - to the 115 V position, the vertical channel current should not exceed 6 mA (the current component of the elevation angle included).

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Check of Altitude Unit for Hermetic Sealing and Operation

Check of altitude unit for hermetic sealing and operation should be performed by using vacuum set КПУ-3 which creates and maintains vacuum in the mechanism of altitude automatic setting.

To perform the check, proceed as follows:

1. Switch on the sight.

2. Place the КПУ-3 handle in the position, prescribed for pumping out.

3. Use set КПУ-3 to pump out air. During the process altitude should change on the altitude unit scale as altitude readings change on vacuum set КПУ-3.

The altitude unit scale readings should correspond to those taken off the КПУ-3 scale (tolerance ±300 m. for an altitude of up to 12,000 m. and ±500 m. for altitudes exceeding 12,000 m.)

Decrease the altitude on vacuum set КПУ-3 down to 6000 m., turn off the cock and check the airtightness of the altitude unit. The altitude as read off the КПУ-3 scale should not decrease with a rate of more than 100 m. per min.

CAUTION: 1. Do not disconnect all vacuum hoses and the air speed tube pressure head until vacuum is completely removed (to avoid damage of the altitude unit of the sight, type АСП-5НД).
2. After the sight has been tested reinstall caps of reference connectors УНГ and КУ.

Chapter IX

TRANSPORTATION AND STORAGE OF SIGHT

1. SERVICE LIFE AND STORAGE GUARANTEED

The service life and storage period guaranteed are specified in the sight Certificate. The Manufacturer guarantees the trouble-free operation of the sight set for 200 working hours within 2 years, including 100 hours in the GYRO position (parts furnished with the SPT&A set may be replaced). The operation and storage regulations are outlined in the Technical Description and Storage Instructions. The storage period of the sight is 1 year, which is not included into the guaranteed term of its service life.

2. TRANSPORTATION

1. The sight should be transported only in the packing case.

2. The Manufacturer packs the packing cases in special shipping boxes.

3. Arrange the packing cases to be shipped with their covers up.

4. Never drop or turn over the cases.

5. Prior to placing the sight head into the packing case, lock the gyro of the sight head (place the lock lever on the sight head on FIXED (НЕПОД.)

6. Pack the sight head in accordance with the Packing Instructions.

Packing Instructions

Sight АСП-5НД is a complicated, precision and costly instrument which requires gentle handling.

Pack the sight set in a special case with utmost care so that it should not be damaged during transportation.

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Place the set in a wooden case in accordance with the Delivery List, seeing that all parts are arranged in their respective seats and reliably secured by appropriate attachment fixtures. The case should bear the sight code number and inscriptions: TOP (ВЕРХ), DO NOT TURN OVER (НЕ КАНТОВАТЬ). Glued to the case is a list of parts placed there. Each case should have a Packing List signed by persons in charge of packing. The small cases and the packing case must be sealed.

Arrangement of Sight Units in Packing Case

1. Unscrew four wing nuts and take upper plate 1 from the case.

2. Put the SPT&A set and mounting set on the lower plate.

3. Place the control box on stops 3, secure it by four screws; wrap the connectors with paper and place them into small case 4.

4. Arrange the voltage regulator on strips 5 and secure it by four screws.

5. Place the computer on the upper plate and secure it by four screws.

6. Arrange altitude unit H on the base plate and lock it by 4 screws.

7. Secure the bracket with the sight head to the plate by a pin and nuts. Fit spring washers under the nuts. Wrap the reflector and light filter with cotton wool and paper. Set the lock lever against FIXED (НЕПОД.).

8. Mount the zero gyro amplifier, relay with base plate and zero gyro into their seats and lock them by screws and wing nuts. Fit strip 6 between the base plate and the amplifier housing and limit the strip travel by clamps.

9. Secure the instrument connectors to respecitive plugs and nuts of the plate.

10. Pass a wire through the holes of wing nuts and rods to prevent the spontaneous unscrewing of the wing nuts.

11. Apply gun grease GOST 3005-51 to the outer surfaces of steel blued parts and attachment fixtures.

12. Put the upper plate into the case and fasten it by four wing nuts.

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13. Press the cables of the zero gyro tight to each other and tie them up with twine.

14. Check all units for safe attachment and close the case.

Note: Remove the sight units from the case in the reverse order.

List

of Parts Placed into Packing Case

1. Sight head 5НД - Assy 1	1 pc.
2. Computer 5НД - Assy 42	1 pc.
3. Zero gyro 5НД - Assy 3	1 pc.
4. Zero gyro amplifier 5НД - Assy 4	1 pc.
5. Control box 5НД - Assy 55	1 pc.
6. Altitude unit 5НД - Assy 6	1 pc.
7. Relay with base plate 5НД - Assy 8	1 pc.
8. Sight head bracket 5НД - Assy 11	1 pc.
9. Voltage regulator CH-4	1 pc.
10. Mounting set	1 pc.
11. Case with SPT&A set 5НД - Assy 9-3	1 pc.
12. Cover 5Н-ЗИП - Assy 1	1 pc.

List

of Parts Placed in Case with Spare Parts, Tools and Accessories and Changeable Units

1. Changeable unit 5k 5НД - Assy 55-69	1 pc.
2. Twin triode 6Н12С	4 pcs
3. Twin triode 6Н1П-В	3 pcs
4. Kenotron 6Ц4П-В	2 pcs
5. Valve 13П1М (13П1С)	1 pc.
6. Lamp СМ-46, 27 V, 18 W	4 pcs
7. Lamp СМ-37	12 pcs
8. Lamp ТН-03 (holder 1Ш9-1)	1 pc.
9. Relay РЭ - Assy 41	2 pcs
10. Relay РП-7	1 pc.
11. Relay РП-5	1 pc.
12. Fuse ПК-30-1А	2 pcs

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13. Fuse ПК-30-0.5А .... 4 pcs
14. Reflector 5НД-1-12 .... 1 pc.
15. Light filter 5Н-11-1 .... 1 pc.
16. Spring-loaded belt 3Н-1-184k .... 2 pcs
17. Plate with brushes for ДР-3.5М(ДР-3.5М-Assy 8k) .... 2 pcs
18. Brush of electric motor ДГ-6 (ДГ-6 - Assy 15k) .... 4 pcs
19. Brush of electric motor ДГ-4М (ДГ-2- Assy 11k) .... 4 pcs
20. Oiler with oil ОКБ-122-5 .. .. 2 (6 gr)
21. Can with lubricant ОКБ-122-7 .... 1 (50 gr)
22. Ampoule with essential oil .... 2 pcs
23. Flannel, 200x200 .... 2 pcs
24. Sandpaper No.320 (30x210) .... 2 pcs
25. Cambric tape, 15x100 .... 10 pcs
26. Wrench, 9x11 .... 1 pc.
27. Wrench, 14x17 .... 1 pc.
28. Gyro adjustment wrench 1-ЗИПР-16к ...... 1 pc.
29. Screw-driver В175x0.7 .... 1 pc.
30. Screw-driver В150x0.4 .... 1 pc.
31. Screw-driver В100x0.3 .... 1 pc.
32. Screw-driver K1761301 .... 1 pc.
33. Sealing putty .... 50 gr
34. Bracket 5Н-ЗИП-10 .... 2 pcs
35. Pincers .... 1 pc.

L i s t

of Mounting Set Parts

1. Plug ШР28ПК7ЭШ9 5НД - Assy 12-1 ... 1 pc.
2. Plug ШР28ПК7ЭШ9 5НД - Assy 12-2 ... 1 pc.
3. Receptacle ШР28ПК7ЭШ9 5Н-МК - Assy 1 .... 1 pc.
4. Receptacle ШР28ПК7ЭГ9 5Н-МК - Assy 3 .... 1 pc.
5. Socket 5Н-МК - Assy 5 .... 1 pc.
6. Plug ШР20ПК28Ш6 5Н-МК - Assy 6 ...... 1 pc.

7. Plug ШР48ПК26ЭГ2 5Н-МК - Assy 7 .... 1 pc.
8. Plug ШР48ПК26ЭГ2 5Н-МК - Assy 8 .... 1 pc.
9. Receptacle ШР48ПК26ЭГ2 5Н-МК - Assy 9 .... 1 pc.
10. Receptacle ШР32ПК14ЭГ5 5Н-МК - Assy 10 ... 1 pc.
11. Range manual introduction potentiometer ПД-2500 - Assy К .... 1 pc.

Packing

The Manufacturer issues closed and sealed cases with the sight set packed in packing cases.

The inner walls of the packing cases should be lined with ruberoid or waterproof paper. The sight set case should not shift in the packing case, which bears inscriptions: TOP (ВЕРХ), DO NOT TURN OVER (НЕ КАНТОВАТЬ), HANDLE WITH CARE (НЕ БРОСАТЬ), FRAGILE (СТЕКЛО).

3. SIGHT STORAGE

The sight set should be stored in cases in storage rooms with minimum humidity and without sharp changes of temperature.

Prior to packing the sight for storage:

1. Check the sight set against the Certificate.
2. Examine the sight set to make sure:

(a) there is no damage (of any kind);
(b) all knobs rotate smoothly;
(c) the sealing putty is intact (restore impaired sealing).

4. MAIN CHANGES IN SIGHT DESIGN EFFECTED FROM BEGINNING OF SIGHT MANUFACTURE

1. In sights, manufactured prior to August, 1960, the minus conductor of the range indicator was connected to the circuit of conductor 4 through the plug connector of the sight head. Selector switches Б-С and НР-30-РС on the sight head bracket connected the plus circuit of relays P_2 and P_3 (See Fig.124).

In sights of later makes the range indicator minus conductor is grounded and the sight head receptacle is used to lead the minus conductor of electromagnetic clutch Р-200

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into the bracket. Selector switches Б-С and НР-30-РС connect the minus conductors of relays P_2 and P_3. When the Б-С switch is set against Б, the minus conductor of electromagnetic clutch P-200 gets disconnected and the plano-parallel plate may be set manually at any required angle.

The sight head brackets, issued prior to Augsust, 1960, are not interchangeable with the brackets of later makes and their replacement is forbidden.

2. From September, 1960, the sights are manufactured with different arrangement of guiding pins of the changeable unit terminal blocks. The terminal blocks are turned through 180° to provide for better conditons of units replacement.

3. From November, 1960, resistor R_5 is withdrawn from the zero gyro amplifier and full filament voltage is supplied to the valves. This modification reduces the time of valves warming-up.

4. From January, 1961, the resistance of the computer potentiometer is changed from 400 ohms to 300 ohms and the potentiometer winding begins from the angle, corresponding to 1.5 sec. The resistances of coils R_{213} and R_{214} are changed from 135 ohms to 500 ohms.

5. From April, 1961, the sight electron relays are furnished with more vibration-proof ceramic valve panels.

6. From April, 1961, the sight is modified to maintain the mean value of the elevation angle vertical component when the damping button is depressed. Additional relay P_{15} and resistor R_{215} are introduced, the latter being connected to the vertical correction circuit.

7. From August, 1961, all plug connectors of the sight cables are replaced by shielded connectors.

8. From December, 1961, Assy 41 is rigidly secured by a clamp and screw with wing nut to avoid the dropping of Assy 41 from its socket at extensive overload (firing).

9. From February, 1962, all the cables of the sight head are secured by wire bands at the whole length to protect against damage when performing the scheduled maintenance operations.

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10. From February, 1962, the electric circuit of switching-on the channels of electron relays Assy 8 and Assy 42 in the base plate Assy 8 is changed to ensure the identical operation of the channels. The electric circuit of the base plate manufactured before February 1962 is shown in Fig. 125.

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Appendix 1

TROUBLE-SHOOTING CHART

Defect	Cause	Location	Remedy
1. Sight reticle image and central pip are not seen when sight is turned on (gear train motor operates)	(a) Illumination lamp blew out	(a) Examine lamp	(a) Replace with spare lamp taken from SPT&A set of given sight
	(b) Illumination circuit is broken	(b) Open rear cover of sight head and check voltage across holder of illumination circuit lamp	(b) Restore reticle illumination circuit, if there is no voltage
2. Illumination intensity of sight reticle and central pip sharply drops	(a) Lamp installed is taken from SPT&A set of another sight	(a) Illumination intensity sharply decreases	(a) Fit lamp from SPT&A set attached to this particular sight
	(b) Horizontal and vertical maladjustment of illumination lamp	(b) Same	(b) Check illumination lamp bracket for reliable attachment. If attachment is loose, dim out reticle brightness and adjust bracket

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Defect	Cause	Location	Remedy
			position to obtain brightest image of reticle against dark background
	(c) Springs arranged on throw-out cover fail to tightly press swinging holder	(c) Illumination intensity sharply decreases	(c) Bend spring arranged on throw-out cover
3. Computer scales Д, T and reticle circle fail to operate. Elevation angle is not computed	(a) No 115 V, A.C, 400 c.p.s.	(a) Connect panel КП5СМ-3 to make sure that there is no voltage	(a) Locate broken conductor and repair it
	(b) No stabilized voltage, 22 V	(b) Same	(b) Same
4. Computer scales Д and T do not follow up time and range at automatic and manual range introduction. Make sure that scale T	(a) Safety fuse of electron relay A.C. circuit has blown out	(a) Inspect fuse in control box (for Assy 42)	(a) Replace it by a spare fuse

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Appendix 1

TROUBLE-SHOOTING CHART

Defect	Cause	Location	Remedy
1. Sight reticle image and central pip are not seen when sight is turned on (gear train motor operates)	(a) Illumination lamp blew out	(a) Examine lamp	(a) Replace with spare lamp taken from SPT&A set of given sight
	(b) Illumination circuit is broken	(b) Open rear cover of sight head and check voltage across holder of illumination circuit lamp	(b) Restore reticle illumination circuit, if there is no voltage
2. Illumination intensity of sight reticle and central pip sharply drops	(a) Lamp installed is taken from SPT&A set of another sight	(a) Illumination intensity sharply decreases	(a) Fit lamp from SPT&A set attached to this particular sight
	(b) Horizontal and vertical maladjustment of illumination lamp	(b) Same	(b) Check illumination lamp bracket for reliable attachment. If attachment is loose, dim out reticle brightness and adjust bracket

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Defect	Cause	Location	Remedy
			position to obtain brightest image of reticle against dark background
	(c) Springs arranged on throw-out cover fail to tightly press swinging holder	(c) Illumination intensity sharply decreases	(c) Bend spring arranged on throw-out cover
3. Computer scales Д, T and reticle circle fail to operate. Elevation angle is not computed	(a) No 115 V, A.C, 400 c.p.s.	(a) Connect panel КП5СМ-3 to make sure that there is no voltage	(a) Locate broken conductor and repair it
	(b) No stabilized voltage, 22 V	(b) Same	(b) Same
4. Computer scales Д and T do not follow up time and range at automatic and manual range introduction. Make sure that scale T	(a) Safety fuse of electron relay A.C. circuit has blown out	(a) Inspect fuse in control box (for Assy 42)	(a) Replace it by a spare fuse

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Defect	Cause	Location	Remedy
does not follow up time at fixed scale Д. Check it by changing over switch HP-30-PC on sight head bracket to PC	(b) When lock lever is set to GYRO, computer motor ДP-3,5M does not operate	(b) Check sockets 1' and 4' of control box connector B-1 for 27 V voltage supplied to electric motor. Voltage being available, check motor circuit at pins 1' and 4' of computer con-nector B-1	(b) Repair broken circuit. If circuit in good repair, clean commutator, replace brushes or electric motor
	(c) No stabilized voltage, 22 V	(c) Check socket 14'of connector B-2 and so socket 5'of connect-or B-1 (arranged in control box) for stabilized voltage, 22 V	(c) Locate and repair broken circuit using circuit dia-gram

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Defect	Cause	Location	Remedy
5. Computer scale Д does not follow up range from manual or automatic range introduction (make sure that scale T follows up time when selector switch HP-30-PC is set to PC)	(a) Safety fuse of electron relay D.C. circuit has blown out	(a) Inspect fuse in computer electron relay	(a) Repair fuse by a brass wire, 0.05 mm in diameter
	(b) Broken circuit of range follow-up Π_{11} potentiometer	(b) Check potentiometer Π_{11} circuit at pins 6' and 7' of computer connector B-2	(b) Open computer and repair broken circuit
	(c) Range unit limit switches are defective (burnt contacts or decreased contact pressure)	(c) Check circuits of range unit limit switches (for proper contacting)	(c) Eliminate discovered fault
	(d) Electron relay range channel is faulty	(d) Locate faulty element of electron relay by testing. Usually fault is eliminated by replacing Assy 41 or valves	(d) Replace the faulty elements by spare ones
	(e) Electromagnetic clutch 2PT-200 fails to operate	(e) See that control windings of electromagnetic clutch (terminals 1 and 2, 3 and 2 of adapter block) are energized with 27 V.	(e) Replace clutch if control windings are energized with 27 V. If windings are not energized, locate and

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Defect	Cause	Location	Remedy
		Introduce mismatching to electron relay input by rotating throttle lever at manual introduction of range	repair broken circuit, consulting sight electric diagram
6. Scale Д does not follow up range from manual range introduction only (and follows it up from automatic range introduction)	(a) Broken circuit of potentiometer Π_{12} arranged in throttle lever	(a) Dismantle throttle lever and use ohmmeter to check circuit potentiometer Π_{12}	(a) Replace potentiometer or repair broken circuit
	(b) Range bridge is not energized with 27 V	(b) Set selector switch RADAR OPTICAL to OPTICAL and check sockets 6' and and 7' of control box connector B-2 for 27 V voltage	(b) If no voltage, check circuit of relay P_8 in control box for proper condition. Eliminate fault
7. Scale Д does not follow up range from automatic range introduction only (following it up from manual introduction)	(a) Radar ranging unit fails to operate	(a) Use panel КП5СМ-3 to check reference voltage of radar ranging unit and make sure that scale Д follows up range from panel	(a) Radar ranging unit is faulty

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Defect	Cause	Location	Remedy
	(b) Broken circuit of relay P_8 or circuit of radar ranging unit type switching	(b) Find fault using electric diagram	(b) Eliminate fault
8. Computer scale T does not follow up time with range introduced	(a) Bridge circuit broken	(a) Check terminals 6' and 7' of control box connector B-1 for voltage. Check potentiometer Π_1 circuit at pins 6' and 7' of computer connector B-1. Check time bridge diagonal for proper condition (See Electric Diagram)	(a) Repair circuit, if broken
	(b) Blown out fuse in D.C. circuit of channel T electron relay	(b) (See Item 5a)	(b) (See Item 5a)
	(c) Limit switches are faulty	(c) (See Item 5c)	(b) (See Item 5c)
	(d) Electron relay time channel is defective	(d) (See Item 5d)	(d) (See Item 5d)
	(e) Electromagnetic clutch 2PT-200 fails to operate	(e) (See Item 5e)	(e) (See Item 5e)

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Defect	Cause	Location	Remedy
		Introduce mismatching to electron relay input by rotating throttle lever at manual introduction of range	repair broken circuit, consulting sight electric diagram
6. Scale Д does not follow up range from manual range introduction only (and follows it up from automatic range introduction)	(a) Broken circuit of potentiometer Π_{12} arranged in throttle lever	(a) Dismantle throttle lever and use ohmmeter to check circuit potentiometer Π_{12}	(a) Replace potentiometer or repair broken circuit
	(b) Range bridge is not energized with 27 V	(b) Set selector switch RADAR OPTICAL to OPTICAL and check sockets 6' and and 7' of control box connector B-2 for 27 V voltage	(b) If no voltage, check circuit of relay P_8 in control box for proper condition. Eliminate fault
7. Scale Д does not follow up range from automatic range introduction only (following it up from manual introduction)	(a) Radar ranging unit fails to operate	(a) Use panel КП5СМ-3 to check reference voltage of radar ranging unit and make sure that scale Д follows up range from panel	(a) Radar ranging unit is faulty

Defect	Cause	Location	Remedy
	(b) Broken circuit of relay P_8 or circuit of radar ranging unit type switching	(b) Find fault using electric diagram	(b) Eliminate fault
8. Computer scale T does not follow up time with range introduced	(a) Bridge circuit broken	(a) Check terminals 6' and 7' of control box connector B-1 for voltage. Check potentiometer Π_1 circuit at pins 6' and 7' of computer connector B-1. Check time bridge diagonal for proper condition (See Electric Diagram)	(a) Repair circuit, if broken
	(b) Blown out fuse in D.C. circuit of channel T electron relay	(b) (See Item 5a)	(b) (See Item 5a)
	(c) Limit switches are faulty	(c) (See Item 5c)	(b) (See Item 5c)
	(d) Electron relay time channel is defective	(d) (See Item 5d)	(d) (See Item 5d)
	(e) Electromagnetic clutch 2PT-200 fails to operate	(e) (See Item 5e)	(e) (See Item 5e)

Defect	Cause	Location	Remedy
9. Self-oscillation of scales Д or of reticle circle	Broken circuit of negative feedback from tachogenerator of electromagnetic clutch 2PT-200	Check circuit of negative feedback in proper channel, according to Key Diagram	Restore circuit
10. When range and base are introduced the reticle circle size does not change	(a) Electric motor ДГ-6 (in sight head) fails to operate	(a) Check voltage supply to motor	(a) Clean motor commutator, replace brushes or electric motor
	(b) Blown out fuse in A.C. circuit	(b) Inspect fuse in control box (for Assy 8)	(b) Replace faulty by a spare one
	(c) Blown out fuse D.C. circuit	(c) Inspect fuse in electron relay Assy 8	(c) Repair fuse by a brass wire, 0.05 mm in diameter
	(d) Faulty channel of reticle circle electron relay	(d) (See Item 5d)	(d) (See Item 5d)
	(e) Broken circuit of reticle circle bridge	(e) Check circuit of reticle circle bridge, consulting sight diagram	(e) Locate and repair broken conductor

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Defect	Cause	Location	Remedy
		(potentiometers and bridge diagonal)	
11. Plano-parallel plate does not operate when selector switch HP-30-PC on sight head bracket is changed to PC (selector switch H-ДУAC is set against H)	(a) Blown out fuse of electron relay Assy 8 A.C. circuit	(a) Inspect fuse in control box (for Assy 8)	(a) Replace fuse by a spare one
	(b) Sight head motor ДГ-6 fails to operate	(b) Make sure that reticle circle does not respond (See Item 10a)	(b) Clean motor commutator, replace brushes or motor
	(c) Electron relay channel of plano-parallel plate follow-up (Assy 8) is faulty	(c) Item 5d	(c) See Item 5d
	(d) Electro-magnetic clutch P-200 fails to operate	(d) See Item 5e	(d) See Item 5e

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Defect	Cause	Location	Remedy
	(e) Circuit of plano-parallel plate bridge is broken	(e) Check circuit consulting sight electric diagram (potentiometers Π_{18}, Π_{19} and bridge diagonal)	(e) Repair broken circuit
12. The plano-parallel plate does not respond to ДУАС (but responds to H)	ДУАС 133-8 fails to operate	Use test set КП5СД to make sure that plano-parallel plate responds to ДУАС simulator	Locate and eliminate fault in circuit of ДУАС 133-8 of potentiometer Π_{20}
13. When ДУАС 133-8 vertical vanes are rotating, the reticle circle with central pip does not move horizontally within the sight field of vision (correction for slip angle β is not followed up)	(a) ДУАС 133-8 fails to operate	(a) Use test set КП5СД to make sure that correction for slip angle β is followed-up from simulator of ДУАС	(a) Eliminate fault in circuit of ДУАС 133-8 of potentio meter Π_{21}
	(b) Broken circuit of computer potentiometer Π_{26}	(b) Use ohmmeter to check Π_{26} circuit on pins 2' and 4' of computer connector B-2	(b) Repair broken circuit or replace Π_{26}

Defect	Cause	Location	Remedy
	(c) Broken circuit of coil K_{HT} of sight head gyro horizontal correction or of coil K_{HTC} of zero gyro	(c) Use panel КП5СМ test set КП5СД to make sure that horizontal correction circuit is de-energized and the reticle central pip is not shifted	(c) Repair broken circuit consulting sight electric diagram
14. No angle of elevation is plotted within field of vision while range is introduced	(a) Safety fuse of zero gyro amplifier has blown out	(a) Detect defect by inspection	(a) Replace blown fuse by a spare one
	(b) Vertical channel of zero gyro amplifier fails to function	(b) Check current in vertical channel of zero gyro amplifier using panel КП5СМ-3 of test set КП5СД	(b) Replace amplifier valves 6Н12С if there is no current in vertical channel of zero gyro amplifier. If there is no current across vertical coils of zero gyro, restore circuit
	(c) Gyro main coil circuit is faulty	(c) Measure current in gyro main coil using panel КП5СМ-3 of set КП5СД	(c) Restore circuit if there is no current

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Defect	Cause	Location	Remedy
15. When sight is set to GYRO, reticle image is displaced within field of vision or is not visible at all	(a) Lock lever fails to switch on	(a) Make sure that computer scales and reticle circle do not respond to range introduction	(a) Eliminate detected fault
	(b) Defective electric motor ДГ-4М of sight head gyro	(b) Check voltage supply to motor	(b) Clean commutator, replace brushes or electric motor
	(c) Spring-loaded belt transmitting rotation from electric motor to gyro is broken	(c) Lock gyro and make sure sight reticle and central pip are seen in field of vision	(c) Replace faulty belt by a spare one
16. Blur of sight reticle and central pip	(a) Frequency of 115 V, A.C. exceeds ±5% allowance or gyro is out of balance	(a) Reticle image blurring disappears with НГ circuit disconnected (zero gyro amplifier safety fuse removed)	(a) Adjust A.C. frequency or balance zero gyro (latter being performed by repair organizations)
	(b) Loss of power of sight head gyro motor or skidding of spring-loaded belt	(b) Change spring-loaded belt, then electric motor ДГ-4М to find out fault	(b) Replace electric motor or spring-loaded belt

Defect	Cause	Location	Remedy
	(c) Main gyro is out of balance (due to loose fastening of gyro dome, mirror, bearings wear out, etc.)	(c) Examine gyro visually	(c) Fault is to be eliminated by repair organization or by Manufacturer
17. Dimmed objective	Broken circuit of optical system heater	Check resistance of optical system heating circuit on pins 2 and 9 of connector Ш-2. It should be about 115 ohms	Eliminate discovered fault
18. Break off signalling circuit is broken	(a) Blown out lamp	(a) Visually examine	(a) Replace it by a spare one
	(b) Polarized relay PП-5 ($P_{sign.}$) in control box fails function	(b) Check it by replacing relay	(b) Replace it by a spare relay
	(c) Computer potentiometer $П_{17}$ burnt	(c) Lamp BREAK-OFF on sight head is continuously lighting	(c) Replace potentiometer $П_{17}$
19. When range is introduced the pointer of range indicator does not move	(a) Range indicator fails to function	(a) Measure voltage at sockets of indicator block	(a) If there is voltage, replace range indicator

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Defect	Cause	Location	Remedy
	(b) Broken circuit of potentiometer П$_{17}$	(b) Same	(b) If there is no voltage, replace potentiometer П$_{17}$ or repair circuit
20. Excessive radio interference	Loose contacts between brushes and commutator in electric motors ДГ-4М, ДГ-6, and ДР-3.5М	Check electric motor commutators and brushes for proper condition	Perform scheduled maintenance of electric motors ДГ-4М, ДГ-6, and ДР-3.5М

Appendix 2

CHECK TABLES

Computed Time T (sec.)

Range, m. / Ballistics	H = 2000 m.				H = 7000 m.			
	600	1000	1400	1800	600	1000	1400	1800
HP-30	0.97	1.89	3.02	-	0.86	1.57	2.44	3.48
C-5M	1.56	2.49	3.52	-	1.48	2.25	3.11	-
	at T < 2 sec. Tolerance Δ ±0.05 sec. at T > 2 sec. – Δ ±0.1 sec.							
C-5K	3 sec. ±0.05							

Table 2

Elevation Angle Vertical Component for Cannon HP-30

H = 7000 m.

Range, m.	600	1000	1800
Angle value	12'	23'	50'
Tolerance	Δ ±12'		

Table 3

Elevation Angles and Correction for Attack Angle α,

T = 3 sec.

Angles of attack α / Ballistics	0°	2°	4°	10°
C-5M	$1^{\circ}13'$	$2^{\circ}43'$	$4^{\circ}13'$	$8^{\circ}43'$
C-5K	$2^{\circ}50'$			
Tolerance	Δ ±30'			

Table 4

Horizontal Component of Slip Angle β Correction

T = 1.5 sec.

Slip angles β / Ballistics	+4°30'	+3°	+1°30'	0	-1°30'	3°	-4°30'
	Right				Left		
C-5M	3°22'	1°56'	0°52'	0	0°52'	1°56'	3°22'
Tolerance	Δ ±30'			Δ ±20'	Δ ±30'		

Table 5

Elevation Angles and Angle of Attack Correction
in Altitude Unit Mode of Operation

T = 3 sec.

Altitude, m. / Ballistics	2000	7000	17,000	20,000 - 25,000
	For aircraft МИГ-21Ф-13			
C-5M	3°08'	3°43'	5°03'	6°16'
Tolerance	Δ ±30'			

Table 6

Reticle Circle Size

Base, m.	23	46	20	60	35	70
Range, m.	100	200	300	900	250	500
Reticle circle size	1°16'		3°41'		7°44'	
Tolerance	Δ ±6'		Δ ±10'		Δ ±20'	

Table 7

Reticle Circle Size in FIXED (НЕПОД.) Position

Base, m. (R of circle in mils)	13	26	40	50	70
Reticle circle size	1°29'	2°59'	4°35'	5°45'	8°
Tolerance	Δ ±10'		Δ ±15'	Δ ±20'	

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Appendix 3

List
of Parts Pertaining to Key Diagram

Designation	Description	Main data	Assy	Note
1	2	3	4	5
П_1	Time potentiometer	1600 ohms ±10%	42	
П_2	Altitude potentiometer for rifled weapons	2700 ohms ±5%	6	
П_3	Altitude potentiometer for rocket weapons	3000 ohms ±5%	6	
П_4	Range functional potentiometer	757 ohms ±5%	42	
П_5	Range functional potentiometer for rocket weapons	819 ohms ±5%	42	
П_{26}	Time potentiometer	300 ohms ±5%	42	
П_7	Time functional potentiometer	158.04 ohms	42	
П_8	Time functional potentiometer	949.94 ohms ±5%	42	
П_9	Time functional potentiometer	949.94 ohms ±5%	42	
П_{11}	Range potentiometer	12,000 ohms ±10%	42	
П_{12}	Potentiometer ПД-2500		12	Accuracy class 3
П_{14}	Transmitting potentiometer ПД-400 (base)		1	Accuracy class 3
П_{15}	Receiving potentiometer ПП-400 (circle)		1	Accuracy class 3

1	2	3	4	5
П_{16}	Range potentiometer	1770 ohms ±10%	42	
П_{21}	Transmitting potentiometer (ДУАС) of circuit β	240 ohms		Not furnished with sight
П_{17}	Range potentiometer	250 ohms ±10%	42	
П_{18}	Receiving potentiometer ПП-400 (plano-parallel plate angles)		1	Accuracy class 3
П_{19}	Altitude potentiometer	800 ±5%	6	
П_{20}	Transmitting potentiometer (ДУАС) of circuit α	1700 ohms		Not furnished with sight
R_2	Fixed wire resistor	1716.9 ohms ±0.1%	55	
R_3	Fixed wire resistor	1981.98 ohms ±0.1%		Part of unit
R_5	Fixed wire resistor	675 ohms ±0.25%		Part of unit
R_6	Fixed wire resistor	2500 ohms ±0.1%	55	
R_7	Adjustable resistor ПС-1000 Assy	500 ohms (rated)	42	
R_8	Adjustable resistor ПС-1000 Assy	500 ohms (rated)	42	
R_9	Adjustable resistor ПС-1000 Assy	200 ohms (rated)	42	

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1	2	3	4	5
R_{10}	Fixed wire resistor	195.05 ohms ±0.25%	55	
R_{010}	Fixed wire resistor	54.1 ohms ± 0.25%	55	
R_{12}	Fixed wire resistor	1213 ohms ±0.1%	55	
R_{13}	Fixed wire resistor	1333.29 ohms ±0.1%		Part of unit
R_{15}	Fixed wire resistor	71.25 ohms ±0.25%		Part of unit
R_{15x}	Fixed wire resistor	534 ohms ±0.25%	55	
R_{16}	Fixed wire resistor	500 ohms ±0.25%	55	
R_{17} R_{27}	Adjustable resistors DC-200 Assy	78.4 ohms (rated) 146.11 ohms (rated)	6 6	
R_{18} R_{28}	Adjustable resistors DC-1000 Assy	500 ohms (rated) 708.9 ohms (rated)	6 6	
R_{19} R_{29}	Adjustable resistors DC-1000 Assy	221.6 ohms (rated) 127.33 ohms (rated)	6 6	
R_{20}	Adjustable resistor DC-50 Assy	28.84 ohms (rated)	55	
R_{22}	Fixed wire resistor	700 ohms ±0.1%	55	
R_{23}	Fixed wire resistor	2797.75 ohms ±0.1%		Part of unit
R_{25x}	Fixed wire resistor	466 ohms ±0.25%	55	

1	2	3	4	5
R_{26}	Fixed wire resistor	500 ohms ±0.25%	55	
R_{30}	Adjustable resistor DC-200 Assy		Γ-Assy	Selected during adjustment
R_{030}	Fixed wire resistor		Γ-Assy	
R^{x}_{31} - R^{x}_{32}	Adjustable resistors DC-200 Assy		8, 42	
R_{32}	Fixed wire resistor	90 ohms ±0.25%	55	
R_{33}	Fixed wire resistor	500 ohms ±0.25%		Part of unit
R_{36}	Fixed wire resistor	750 ohms ±0.1%	55	
R_{37H}	Adjustable resistors DC-200 Assy	116 ohms (rated)	42	
R_{37P}		128.4 ohms (rated)	42	
R_{38}	Fixed wire resistor	1050 ohms ±0.1%	55	
R_{39H}	Adjustable resistors DC-200 Assy	100 ohms (rated)	42	
R_{39P}		50 ohms (rated)	42	
R_{40}	Fixed wire resistor	5.35 ohms ±3%	55	
R_{42}	Fixed wire resistor	305.4 ohms ±0.25%	55	
R_{43}	Fixed wire resistor	241 ohms ±0.25%		Part of unit
R_{46}	Fixed wire resistor	75.67 ohms ±0.25%		Part of unit

1	2	3	4	5
R_{47}	Adjustable resistor DC-50 Assy		55	
R_{48}	Adjustable resistor DC-200 Assy		55	
R_{048}	Adjustable wire resistor	50 ohms (rated)	55	
R_{49}	Adjustable resistor DC-50 Assy		HT-Assy	
R_{50-51}	Adjustable wire resistors	12.37 ohms ±1% 22.77 ohms ±0.25%	55	Part of unit
R_{52}-R_{53}	Adjustable resistors DC-200 Assy	104 ohms (rated) 59 ohms (rated)	55 42	
R_{54}, R_{56}	Fixed wire resistors	600 ohms ±0.25% 1050 ohms ±0.1%	55 55	
R_{55}, R_{57}	Adjustable resistors DC-200 Assy	124 ohms (rated) 54.2 ohms (rated)	55 55	
R_{057}	Fixed wire resistor	260 ohms ±0.25%	55	
R_{58}	Adjustable resistor DC-1000 Assy	667.7 ohms (rated)	55	
R_{59}	Adjustable resistor DC-200 Assy	118.8 ohms (rated)	6	

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1	2	3	4	5
R_{47}	Adjustable resistor DC-50 Assy		55	
R_{48}	Adjustable resistor DC-200 Assy		55	
R_{048}	Adjustable wire resistor	50 ohms (rated)	55	
R_{49}	Adjustable resistor DC-50 Assy		HF-Assy	
R_{50-51}	Adjustable wire resistors	12.37 ohms ±1% 22.77 ohms ±0.25%	55	Part of unit
R_{52}-R_{53}	Adjustable resistors DC-200 Assy	104 ohms (rated) 59 ohms (rated)	55 42	
R_{54}, R_{56}	Fixed wire resistors	600 ohms ±0.25% 1050 ohms ±0.1%	55 55	
R_{55}, R_{57}	Adjustable resistors DC-200 Assy	124 ohms (rated) 54.2 ohms (rated)	55 55	
R_{057}	Fixed wire resistor	260 ohms ±0.25%	55	
R_{58}	Adjustable resistor DC-1000 Assy	667.7 ohms (rated)	55	
R_{59}	Adjustable resistor DC-200 Assy	118.8 ohms (rated)	6	

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1	2	3	4	5
R_{60}	Fixed wire resistor	500 ohms ±0.25%	6	
R_{61}	Adjustable resistor DC-200 Assy	101.1 ohms (rated)	6	
R_{62}	Fixed wire resistor	1200 ohms ±0.1%	6	
R_{63}	Adjustable resistor DC-200 Assy	59 ohms (rated)	42	
R_{64}	Adjustable resistor DC-1000 Assy	555.5 ohms (rated)	6	
R_{65}	Same	336.67 ohms (rated)	6	
R_{66}	Same	359.4 ohms (rated)	55	
R_{67}	Adjustable resistor DC-200 Assy	84.6 ohms (rated)	55	
R_{067}	Fixed wire resistor	285 ohms ±0.25%	55	
R_{68}	Fixed wire resistor	250 ohms ±0.25%	6	
R_{73}	Fixed wire resistor	10 ohms ±0.5%	55	
R_{073}	Fixed wire resistor	6.75 ohms	42	
R_{77}	Adjustable wire resistor	17.6 ohms (rated)		T-Assy
R_{077}	Adjustable wire resistor	15 ohms (rated)	55	

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1	2	3	4	5
R_{78}	Adjustable resistor	105 ohms (rated)	55	
R_{91}	Fixed wire resistor	4445 ohms ±0.1%	55	
R_{92}	Fixed wire resistor	2123.2 ohms ±1%	55	
R_{93}	Fixed wire resistor	3350.6 ohms ±0.1%	55	
R_{093}	Fixed resistor МЛТ-0.5-30,000-II-A	30 kilohms	55	
R_{95}	Fixed wire resistor	265.4 ohms ±0.25%	55	
R_{96}	Fixed wire resistor	530.8 ohms ±0.25%	55	
R_{97}	Adjustable wire resistor	1522 ohms (rated)	42	
R_{98}	Adjustable resistor ПС-5000 Assy		42	
R_{098}	Fixed wire resistor	6000 ohms ±1%	42	
R_{99}	Adjustable wire resistor	383 ohms (rated)	42	
R_{101}	Adjustable resistor ПС-200 Assy	36.78 ohms (rated)	55	
R_{139}	Adjustable wire resistor	1.7 ohms ±0.5%	Г-Assy	
R_{152}	Fixed wire resistor	180 ohms ±0.25%	55	
R_{154}	Fixed wire resistor	420 ohms ±0.25%	55	

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1	2	3	4	5
R_{160}	Adjustable resistor DC-1000 Assy	540 ohms (rated)	1	
R_{173}	Fixed wire resistor	2500 ohms ±5%	42	
R_{175}	Fixed wire resistor	5500 ohms ±0.1%	6	
R_{176}	Fixed wire resistor	600 ohms ±0.1%	6	
R_{178}	Fixed wire resistor	2550 ohms ±1%	55	
R_{188}	Fixed wire resistor	1490 ohms ±1%	55	
R_{189}	Adjustable resistor DC-1000 Assy		55	
R_{201}	Adjustable resistor DC-1000 Assy	593 ohms (rated)	55	
R_{203}	Fixed wire resistor	20 ohms ±5%	3	
R_{0203}	Adjustable wire resistor	20 ohms (rated)	3	
R_{204}	Fixed resistor MJT-0.5-62,000-II-A	62 kilohms	55	
R_{205}	Fixed resistor MJT-0.5--51,000-II-A	51 kilohms	55	
R_{0205}	Resistor CH-II-0C-3A-1BT-100K	100 kilohms	55	
R_{206}	Fixed resistor MJT-0.5--62,000-II-A	62 kilohms	11	
R_{207}	Same	62 kilohms	55	
R_{208}	Fixed wire resistor	506.73 ohms ±0.25	55	

1	2	3	4	5
R_{209}	Same	250.78 ohms ±0.25%	55	
R_{210}	Same	117.03 ohms ±0.25%	55	
R_{211}	Same	107.85 ohms ±0.25%	55	
R_{212}	Fixed resistor МЛТ-0.5-10,000-II-A	10 kilohms	55	
R_{213}	Fixed wire resistor	500 ohms ±0.25%	55	
R_{214}	Same	500 ohms ±0.25%	55	
R_{246}	Same	150 ohms ±0.25%		Part of unit
R_{251}	Same resistor	96.46 ohms ±0.25%		Part of unit
R_{303}	Same	2500 ohms ±0.1%		
R_{310}	Same	135 ohms ±0.5%	42	
R_{215}	Adjustable wire resistor	3500 ohms (rated)	55	
R_{311}	Adjustable resistor ПС-200 Assy	47 ohms (rated)	1	
R_{351}	Fixed wire resistor	57.01 ohms ±1%		Part of unit
R_{451}	Same	66.3 ohms ±1%		
R_{503}	Same	1733.01 ohms ±0.1%		
r_1	Fixed resistor МЛТ-0.5-5100-II	5.1 kilohms	11	
r_3	Fixed wire resistor	2x50 ohms ±1%	55	
r_4	Resistor ПЭВ-10-510-II	510 ohms ±10%	3	
r_7	Fixed wire resistor	25 ohms ±1%	55	
r_{11}	Fixed wire resistor	100 ohms ±1%	55	

1	2	3	4	5
r_{16}	Fixed wire resistor	18.8 ohms ±0.5%	42	
r_{17}	Fixed wire resistor	50 ohms ±1%	1	
r_{19}	Fixed wire resistor	4000 ohms	11	
$R_{Д}$	Fixed resistor BC-1-1-18,000-II	18 kilohms	3	
R_{t_1}, R_{t_2}, R_{t_3}	Thermistors MMT-4a--1.2 kilohms	1.2 kilohms	Г-Assy	
K_y1	Prediction coil	385 turns, 4.7 ohms	Г-Assy	
K_y2	Prediction coil	335 turns, 7.7 ohms	Г-Assy	
K_y3	Prediction coil, correcting	281 turns, 462 ohms	Г-Assy	
r_{u_1}, r_{u_2}, r_{u_4}	Spark-quenching resistors BC-0.25-1--110-II	110 ohms	3 Г-Assy	
C_{u_1}, C_{u_2}, C_{u_4}	Spark-quenching capacitors КСБ-И-2-Б--200-0.1-II	0.1 μF	3 Г-Assy	
P_2, P_3, P_8, P_9	Relay PC-13	PC 4523017	55	
P_{15}	Damping relay, type PCM-1	Ю1718137	55	
P_{11}, P_{12}, P_{17}	Heater relay (АН-Assy 1-323)		Г-Assy	Assy 3
C_{17}, C_{18}	Filter capacitors	ЭТО-1-50-20 ±20%-Б УБО 464014 ТУ	55	
$P_{омг}$	Relay PП-5	PC 4523009	55	

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1	2	3	4	5
$Р_{зо}$	Electromagnetic limiter relay, type РП-7	РС 4521007 оп	55	
$Рг_1$	Electromagnetic clutch	Р-200 Assy K	1	
$Р_{тт}$	Electromagnetic clutch with tachogenerator	2РТ-200-Assy K	42	
$Р_{тд}$	Same	2РТ-200-Assy K	42	
$Р_{тк}$	Same	2РТ-200-Assy K	1	
$М_д$	Electric motor ДГ-6	P = 6 W; n = 4900-5600 r.p.m.	Г-Assy	
$М_в$	Electric motor ДР-3.5М	P = 3.5 W n = 8500 r.p.m.	42	
$М_н$	Two-phase induction electric motor ДИД-0.5	P = 0.5 W; n = 7500 r.p.m.	6	
$М_{нг}$	Zero gyro electric motor	Rm_1 = 118 ohms; Rm_2 = 118 ohms	НГ-Assy	
$М_г$	Electric motor ДГ-4М	P = 4 W n = 5300 r.p.m.	Г-Assy	
ИД	Inductive transmitter	P = 4 W; n = 5330 r.p.m.	НГ-Assy	
РЭ-1	Electron relay		42	
РЭ-2	Same		8	
Тр-1	Power transformer	I - mains winding, 115 V, 400 c.p.s. n = 2000 turns; II-secondary winding; n = 605 turns, 35 V; III-secondary winding; n = 2x240 turns, 13.8 Vx2	6	

[redacted]

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1	2	3	4	5
Tp-2 Tp-3 Tp-4	Transformers	I-n = 200 II-n = 4100	42 42 Assy 1	
$K_{НГГ}$	Zero gyro horizontal coils	R = 2x180 ohms; n = 2x1500	НГ-Assy	
$K_{НГВ}$	Zero gyro vertical coils	R = 2x165 ohms; n = 2x3000 ohms	НГ-Assy	
$K_{НГП}$	Zero gyro sighting circuit coils	R = 2x11 ohms; n = 2x135	НГ-Assy	
$K_{НГС}$	Zero gyro slip circuit coil	R = 2x100 ohms; n = 2x2000	НГ-Assy	
$K_{НГО}$	Zero gyro main coil	R = 40 ohms; n = 900	НГ-Assy	
$K_{КГ}$	Horizontal correction coil	R = 200 ohms; n = 3500	Г-Assy	
$K_{КВ}$	Vertical correction coil	R = 200 ohms; n = 3500	Г-Assy	
$K_{ИДГ}$ $K_{ИДВ}$	Inductive transmitter coils	R = 195 ohms; n = 3000	НГ-Assy	
C_1, C_2	Capacitors КБГ-И--200-0.01 to 0.04 - II	0.01 - 0.04 µF	3	Selected during adjustment
C_3	Capacitor МБГП-2-200-2-А-II	2 µF	55	
C_4	Capacitor МБГП-3--400-0.25-I	0.25 µF	3	
C_5, C_6	Capacitors КБГ-И-200-0.1-II	0.1 µF	3	

1	2	3	4	5
C_7, C_8	Capacitors МБГП-2-160-2x0.5-I	2x0.5 µF	6	
Сп_1, Сп_2, Сп_3, Сп_4	Capacitors КБП-Р-250-10-0.25-III	0.25 µF	Г-Assy	
Сп_5, Сп_6	Capacitors КБП-С-110-20-0.25-III	0.25 µF	42	
T_1	Gyro heater thermoregulator	$t_{out-off} = +70^\circ \pm 2^\circ C$	НГ-Assy	
T_2	Base plate heater thermoregulator	$t_{out-off} = +30 \pm 2^\circ C$	3	
T_4	Thermoregulator	$t_{out-off} = +60^\circ \pm 2^\circ C$	Г-Assy	
O_1	Zero gyro heater	R = 64 ohms	НГ-Assy	
O_2	Zero gyro heater	R = 26 ohms	НГ-Assy	
O_4, O_5, O_6, O_7	Zero gyro base plate heaters	R = 15 ohms x4	НГ-Assy	
O_8	Gyro inner heater	R = 29.6 ohms	Г-Assy	
O_9	Gyro inner heater	R = 8 ohms	Г-Assy	
O_{10}	Gyro inner heater	R = 8.6 ohms	Г-Assy	
O_{11}	Gyro inner heater	R = 8.7 ohms	Г-Assy	
O_{12}	Objective heater	R = 230 ohms	1	
O_{13}	Mirror heater	R = 230 ohms	1	
$K_{НВО}$	Contact electromagnetic limiter ЭНМ-1-415К		Г-Assy	
ВКП_1	Switch			Aircraft equipment
ВКП_2	Ganged switch			Aircraft equipment
КВ	Limit switch		6	

1	2	3	4	5
КВар	Lock limit switch КВ-9		1	
КВН	Altitude follow-up slide contact group		6	
$П_{кр-1}$	Radar ranging unit selector		55	
$П_{кр-2}$	Radar ranging unit selector		42	
Пкр	Ballistics selector		11	
Пкв	Function switch			
Пкс			11	
$Л_3$	Pilot lamp СМ-37	28 V, 1.5 W	1	
$Л_1$	Illumination lamp СМ-46	27 V, 18 W	1	
$Л_4$	Lock-on lamp СМ-37		1	
$Л_7$	Warning lamp (high voltage on)		11	
	ТН-0.3 holder 1Ш9			
$R_л$	Illumination rheostat РПС-100		1	
Д	Range indicator		11	
$К_{нд}$	Damping button			Aircraft equipment
Пкво	High-voltage selector		11	
Пр1 Пр2	Safety fuses ПК-30-0.5А	0.5 A	55	

APPENDIX No.4

ELECTRIC DIAGRAMS OF SIGHT MAIN CIRCUITS

See Figs. 129-133 (pp. 287-291)

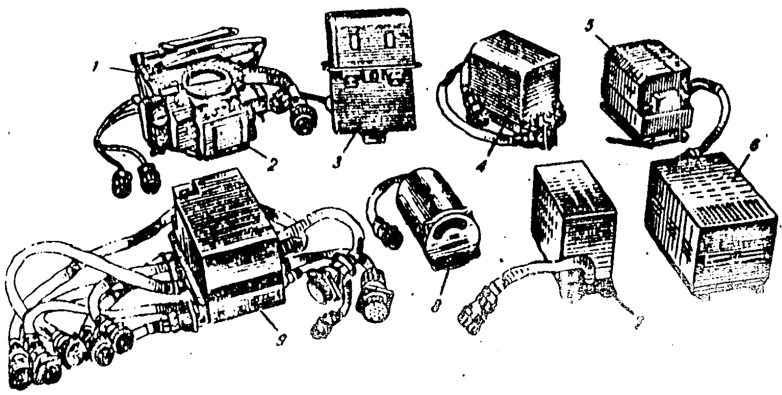

FIG.1. SIGHT SET UNITS
1 - sight bracket with light filter; 2 - sight head; 3 - computer; 4 - aero gyro; 5 - aero gyro [illegible]; 6 - voltage [illegible]; 7 - [illegible] relay with base plate; 8 - altitude unit; 9 - control box.

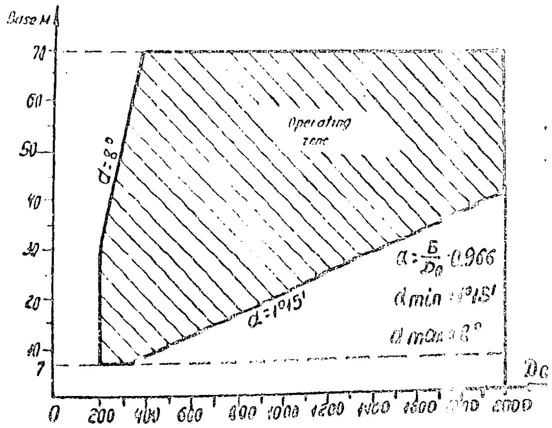

FIG.2. RANGES AND LIMITS OF SIGHT RETICLE CIRCLE SIZE FOR [illegible]

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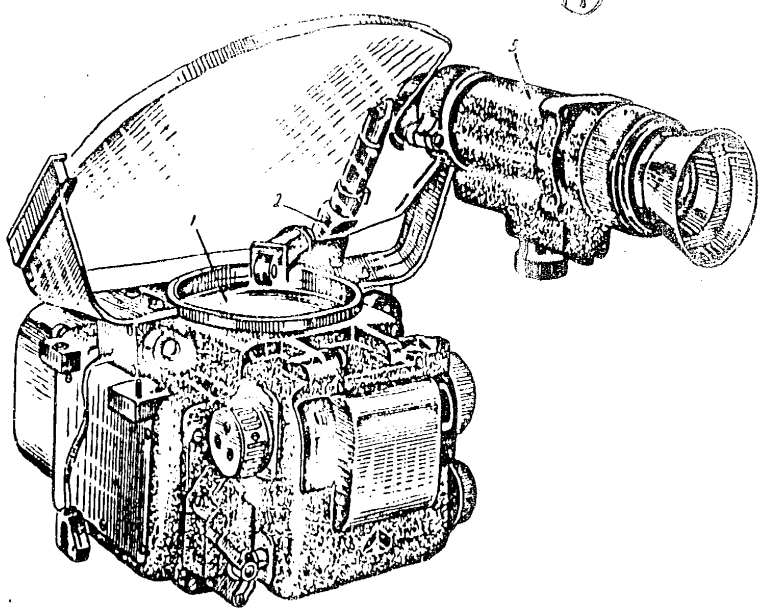

FIG.3. SIGHT HEAD FOR SIGHTING DEVICE СПН-52 (GENERAL VIEW)
1 - head; 2 - special optical attachment; 3 - infra-red sighting device СПН-52.

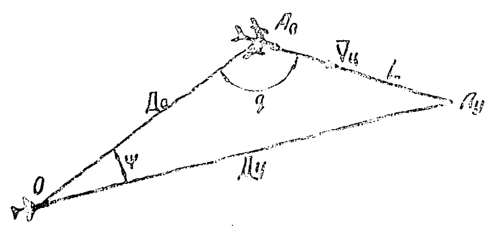

FIG.4. PREDICTION TRIANGLE

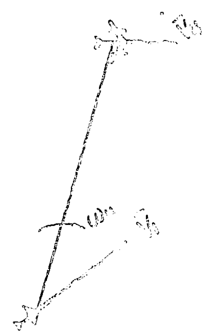

FIG.5.

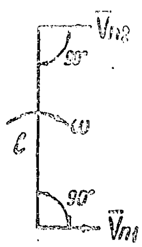

FIG.6.

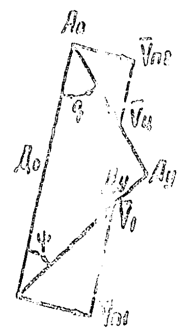

FIG.7.

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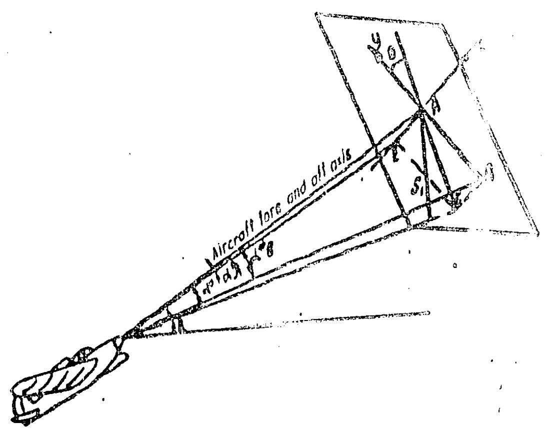

FIG.8. DETERMINATION OF σ_1^n AND σ_1^s

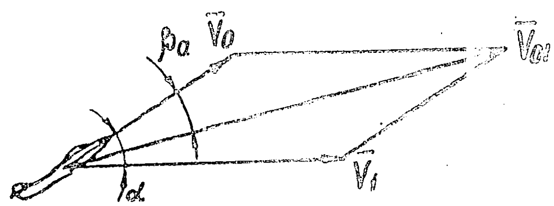

FIG.9. INFLUENCE OF AIRCRAFT SLIP ANGLE UPON PROJECTILE PATH

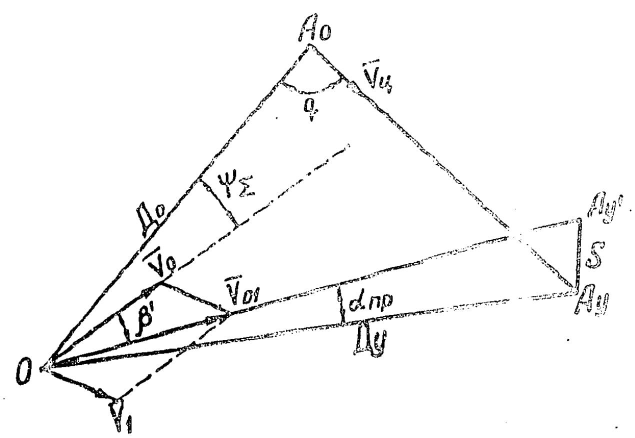

FIG.10. AIR SHOOTING SIGHTING DIAGRAM

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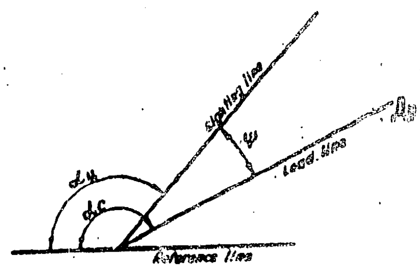

FIG.11.

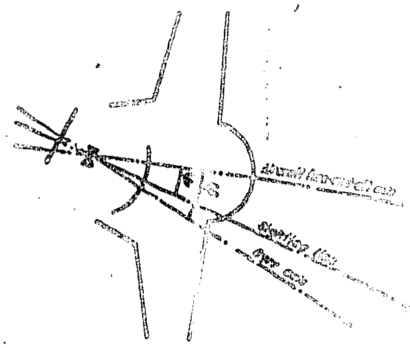

FIG.12, ANGLES OF GYRO [illegible] SIGHTING LINE [illegible] DURING TRACKING A TARGET

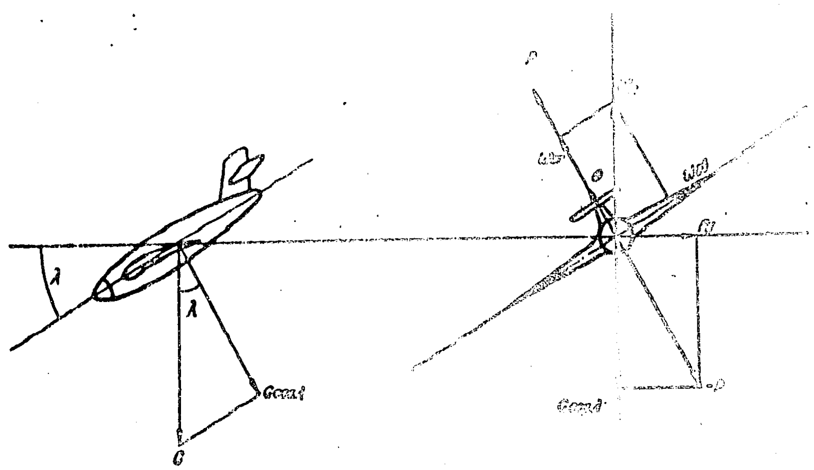

FIG.13.

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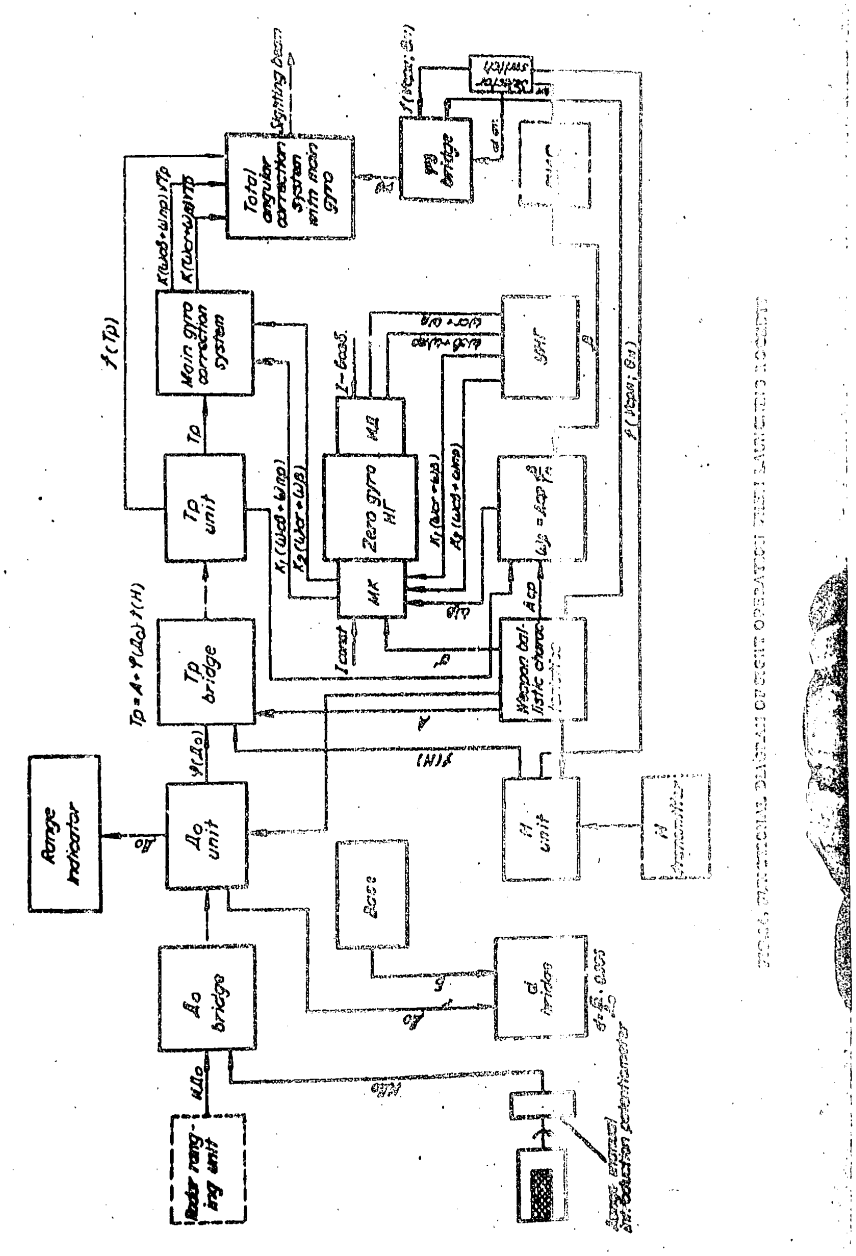
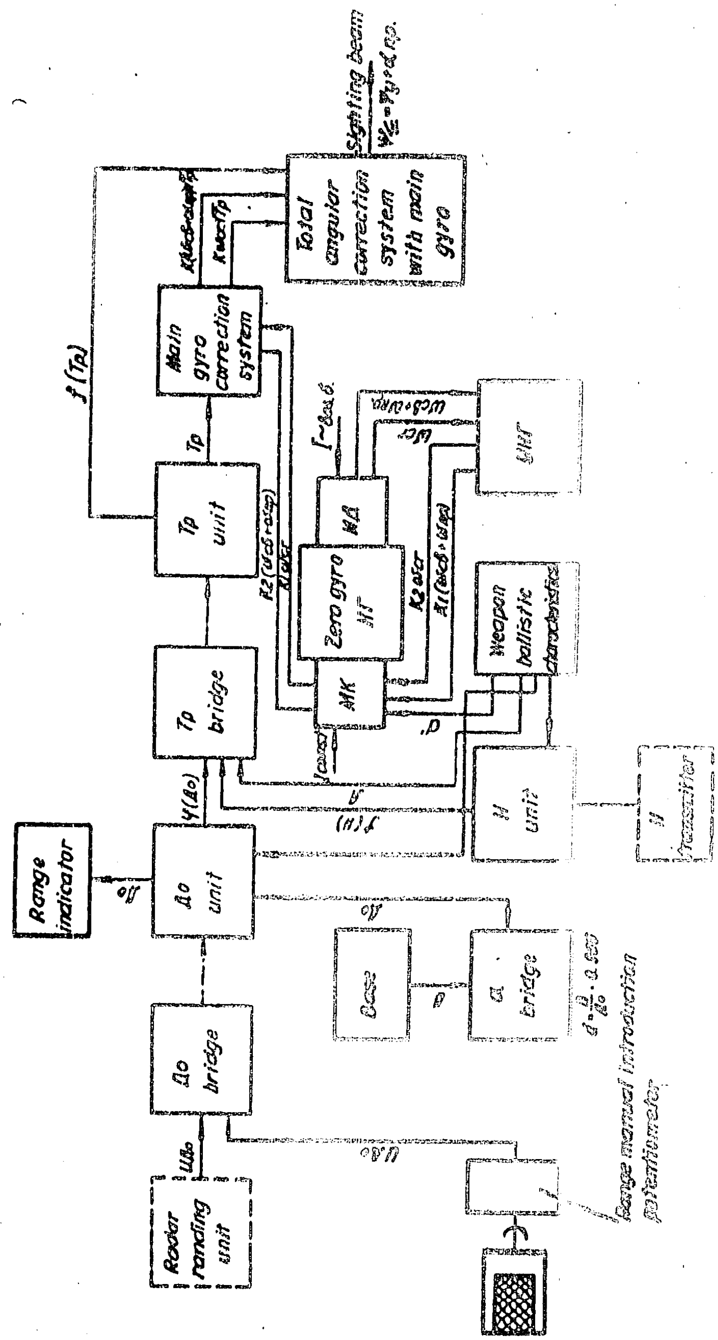

Range indicator
Radar ranging unit
Total angular correction system with main gyro
Sighting beam
Main gyro correction system
Zero gyro
selector switch


Sighting beam
Total angular correction system with main gyro
Main gyro correction system
Tp unit
Tp bridge
Zero gyro
MK
Weapon ballistic characteristics
H unit
H transmitter
Range indicator
Дo unit
Дo bridge
Radar randing unit
Base
a bridge
Range manual introduction potentiometer

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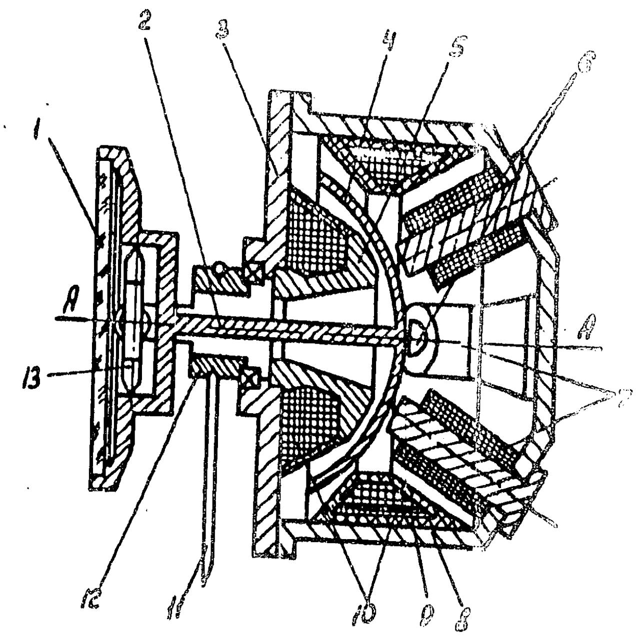


FIG.16. GYRO DESIGN DIAGRAM

1 - mirror in mounting; 2 - gyro axle; 3 - cover; 4 - aluminium dome; 5 - poles; 6 - core; 7 - gyro correction coils windings; 8 - housing; 9 - negative winding (Ky3); 10 - main coil windings; 11 - spring belt; 12 - pulley; 13 - gimbal.

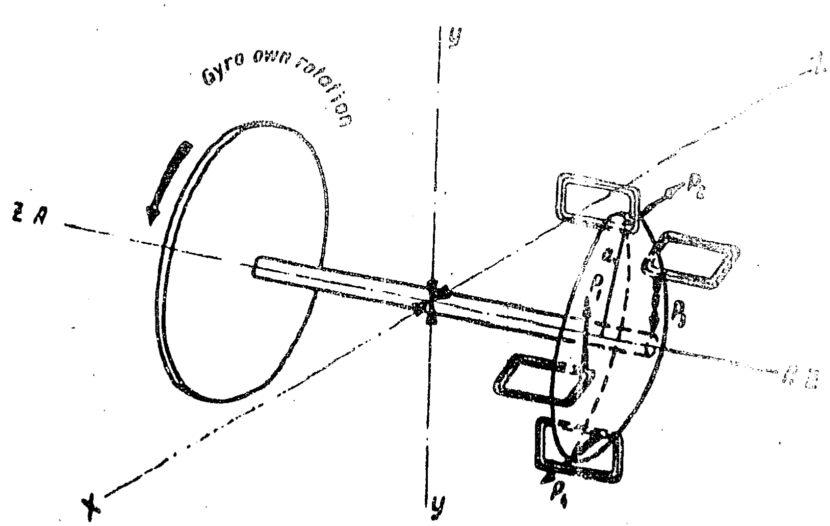


FIG.17. SCHEMATICAL DESCRIPTION OF MAGNETIC FLUXES AND GYRO DOME MUTUAL ARRANGEMENT

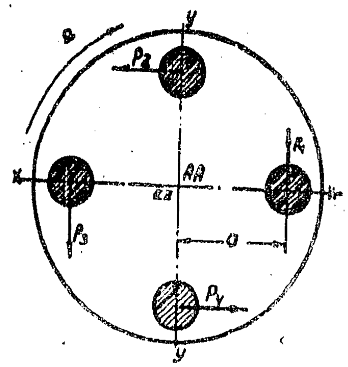


FIG.18. SCHEME OF FORCES ACTING ON GYRO IN ZERO POSITION (GYRO MAGNETIC SYSTEM AXES COINCIDE)

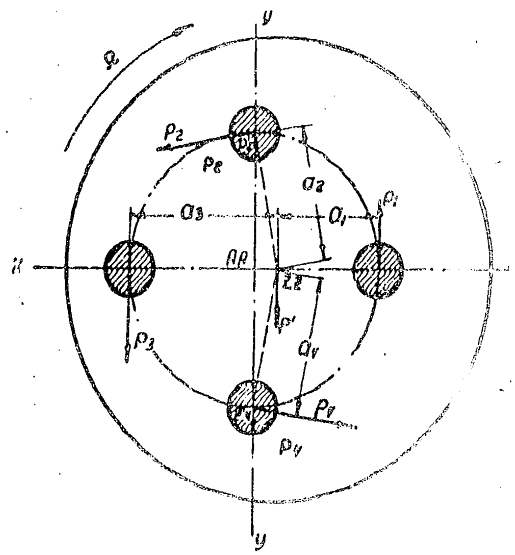


FIG.19. SCHEME OF FORCES ACTING ON GYRO IN CASE OF MISMATCHED ANGLE (GYRO AND MAGNETIC SYSTEM AXES DO NOT COINCIDE)

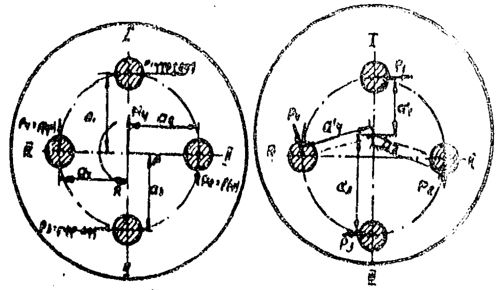
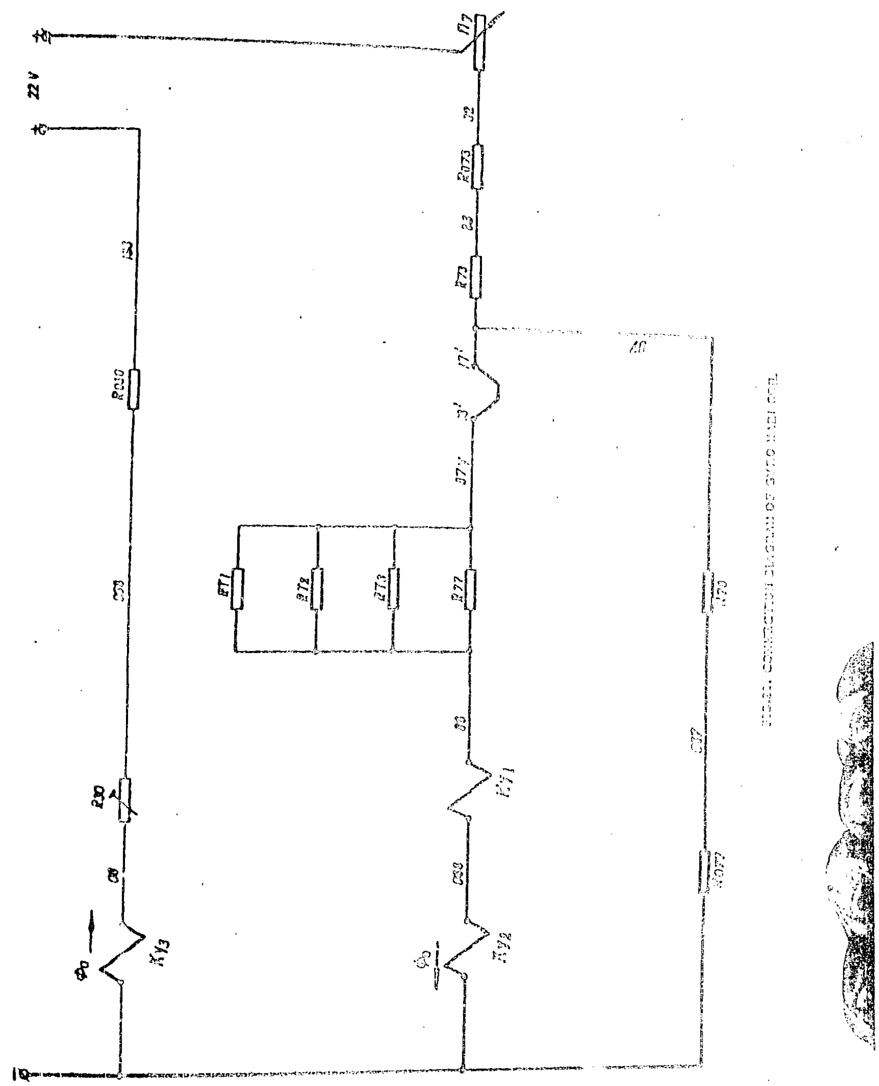


FIG.20. SCHEME OF FORCES ACTING ON GYRO WHEN CURRENT FLOWS ACROSS VERTICAL ADDITIONAL COILS



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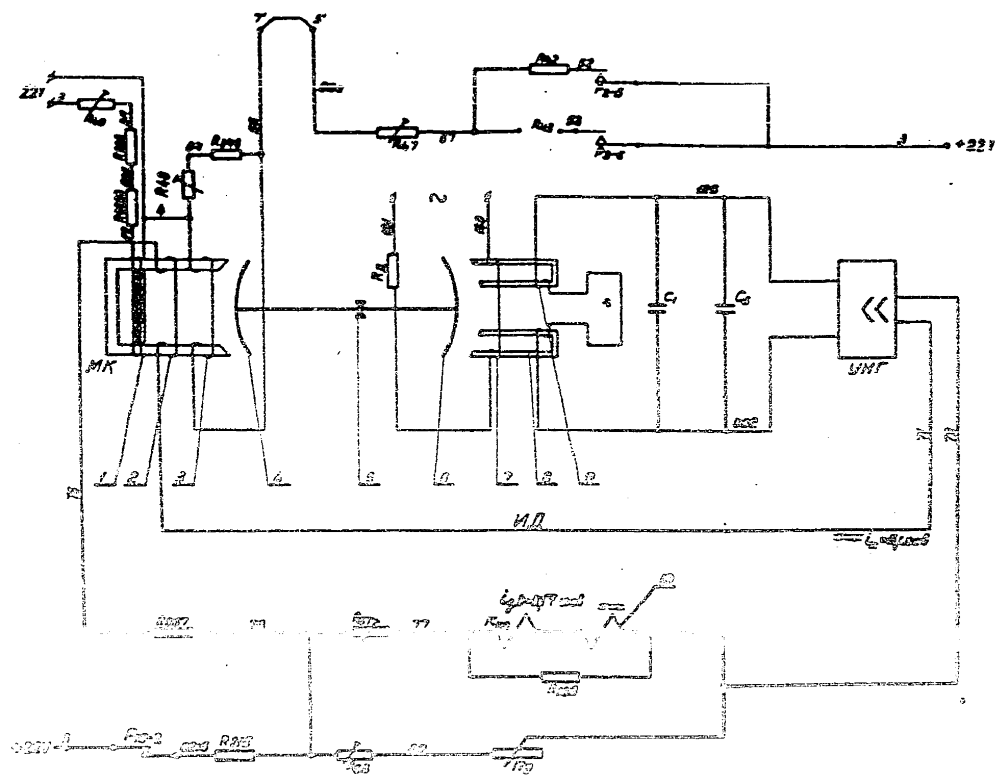

FIG. [illegible]. KEY DIAGRAM OF ZERO GYRO (НГ) FOR MEASURING VERTICAL COMPONENT OF AIRCRAFT ANGULAR VELOCITY
МК - magnetic correction device; ИД - inductive transmitter; УНГ - zero gyro amplifier; 1 - МК main coil [illegible]; 2 - МК correction coils [illegible]; 3 - МК [illegible] coil [illegible]; 4 - aluminium [illegible]; 5 - gyro axle; 6 - armature; 7 - ИД primary coils (exciting [illegible]); 8 - [illegible] magnetic conductor of inductive transmitter; 9 - ИД secondary coils [illegible]; 10 - right-hand gyro additional coils [illegible].

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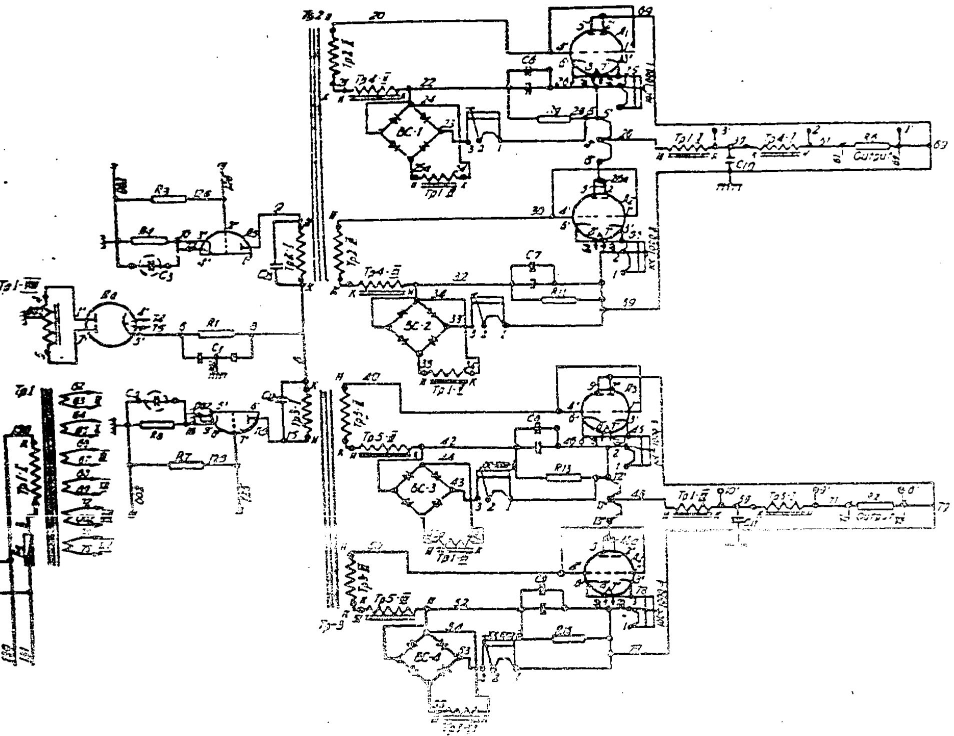

Л1, Л2, Л3, Л4 - Powerful double triode with separate cathodes, 6Н12С

Л5 - Double triode with separate cathodes, 6Н1П

Л6 - Two-plate kenotron 6Ц4П

Tp1 - Power transformer

Tp1-I - Mains winding, 115V, 400 cps, 230 turns

Tp1-II, Tp1-V - Plate windings, 230 V, 450 turns

Tp1-III, Tp1-IV, Tp1-VI, Tp1-VII - Bias windings, 44 V, 88 turns

Tp1-VIII - Rectifier supply winding, 2×115V, 2×230 turns

Tp1-IX, Tp1-X, Tp1-XI, Tp1-XII, Tp1-XIII, Tp1-XIV - Filament windings, 6.5 V, 13 turns

Tp2 - Intervalve transformer

Tp2-I - Plate winding, 1800 turns

Tp2-II - Grid winding Л1 - 5400 turns

Tp2-III - Grid winding Л2 - 5400 turns

Tp3 - Intervalve transformer

Tp3-I - Plate winding, 1800 turns

Tp3-II - Grid winding Л3 - 5400 turns

Tp3-III - Grid winding Л4 - 5400 turns

Tp4 - Feedback transformer

Tp4-I - Primary winding, 1500 turns

Tp4-II, Tp4-III - Secondary windings, 5400 turns

Tp5 - Feedback transformer

Tp5-I - Primary winding, 1500 turns

Tp5-II, Tp5-III - Secondary windings, 5400 turns

R1 - Filter resistor, BC-1-1-1500-II-A

R2 - Amplifier output shunting resistor, BC-0.25-1-10000-II-A

R3 - Grid-leak resistor, BC-0.25-1-0.18-II-A

R4 - Cathode automatic bias resistor, BC-0.25-1-300-II

R5 - Amplifier output shunting resistor, BC-0.25-1-10,000-II-A

R7 - Grid-leak resistor, BC-0.25-1-0.15-II-A

R8 - Cathode automatic bias resistor, BC-0.25-1-300-II

R9; R10; R13; R15 - Grid-leak resistor, BC-0.25-1-5100-II (BC-0.25-1-4700-II)

BC1; BC2; BC3; BC4 - Selenium rectifier BCB-1

C3; C5 - Automatic bias filter capacitor, КЭГ-1-15-30

C6; C7; C8; C9 - Bias filter capacitor, МБГП-3-200-2×0.5

C10, C11 - Output filter capacitor, МБГП-2-160-15-I

П1 - Safety fuse, 1A

C12, C13 - Capacitor, type МБГП-2-3-400-0.05-II

Adjustable resistors

FIG.23. KEY ELECTRICAL DIAGRAM OF ZERO GYRO AMPLIFIER

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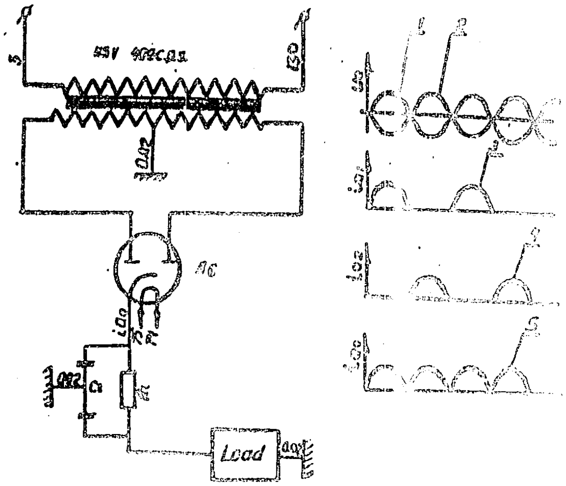


FIG.34. FULL-WAVE RECTIFICATION AND CHART OF RECTIFICATION PROCESS

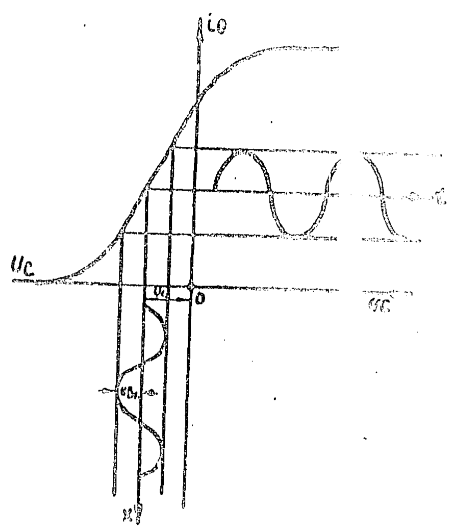


FIG.35. CHART OF ANODE CURRENT VARIANCE

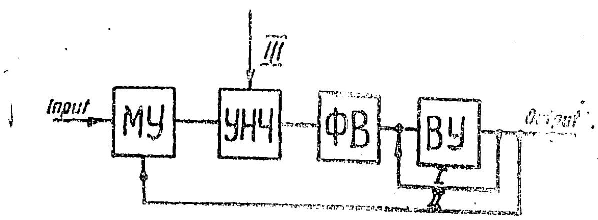


FIG.26. BLOCK DIAGRAM OF FIXED RELAY

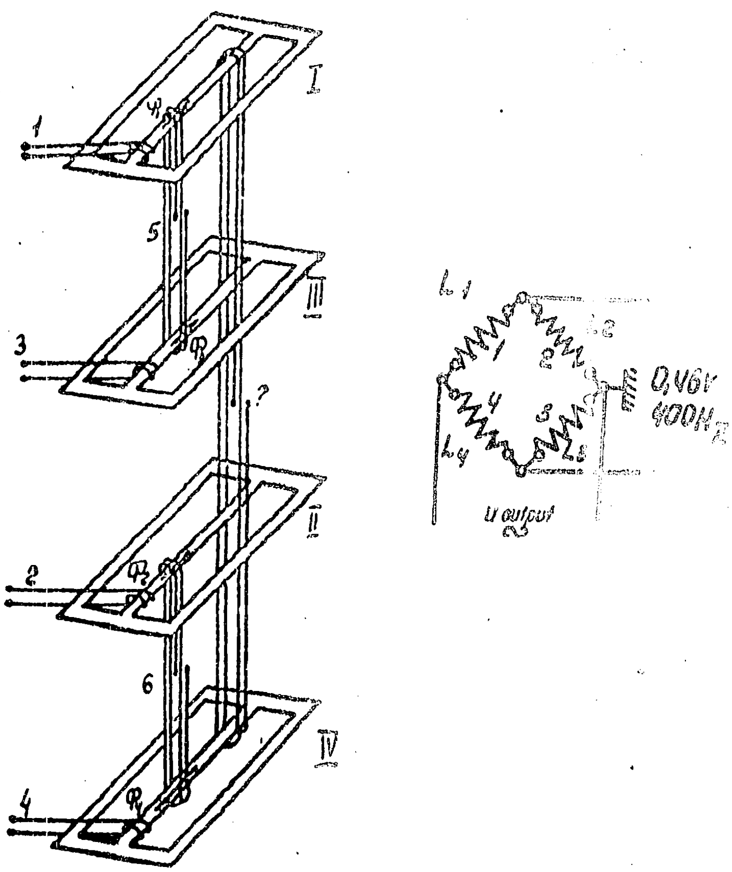
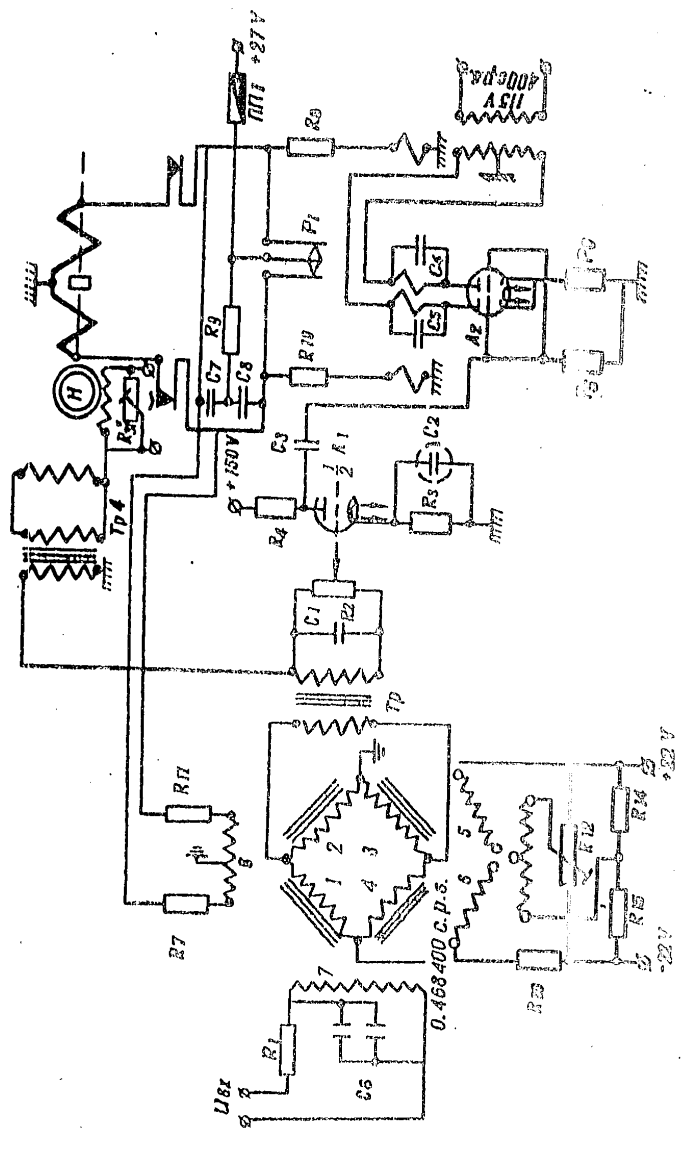


FIG.27. MAGNETIC AMPLIFIER


+27 V
115 V
400 cps.
+150V
0.468 400 c.p.s.
+22 V
-22 V
Tp 4
Tp
Uвх

SECRET
NO FOREIGN DISSEM

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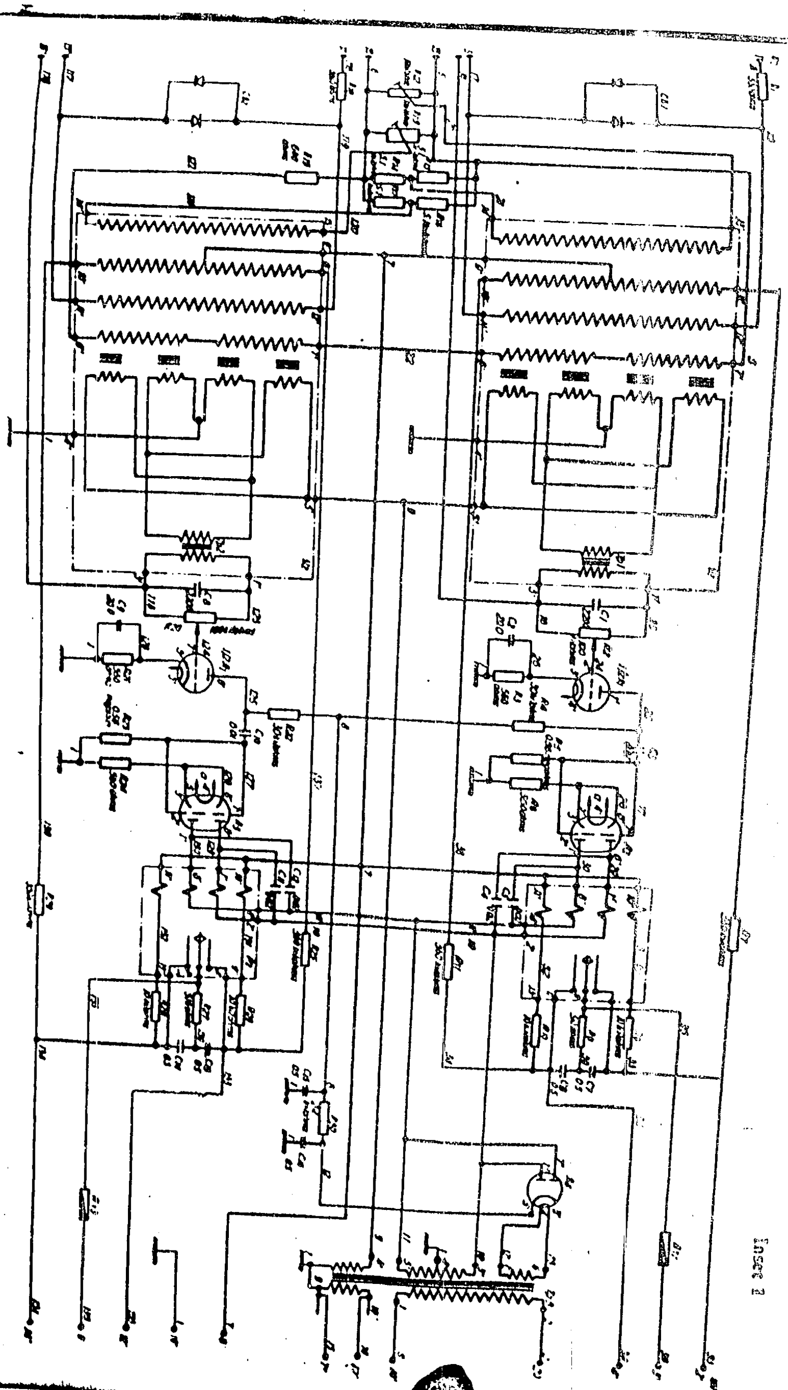

FIG. 29. ELECTRON RELAY DIAGRAM

СХЕМА ЭЛЕКТРОННОГО РЕЛЕ

SECRET
NO FOREIGN DISSEM

50X1-HUM

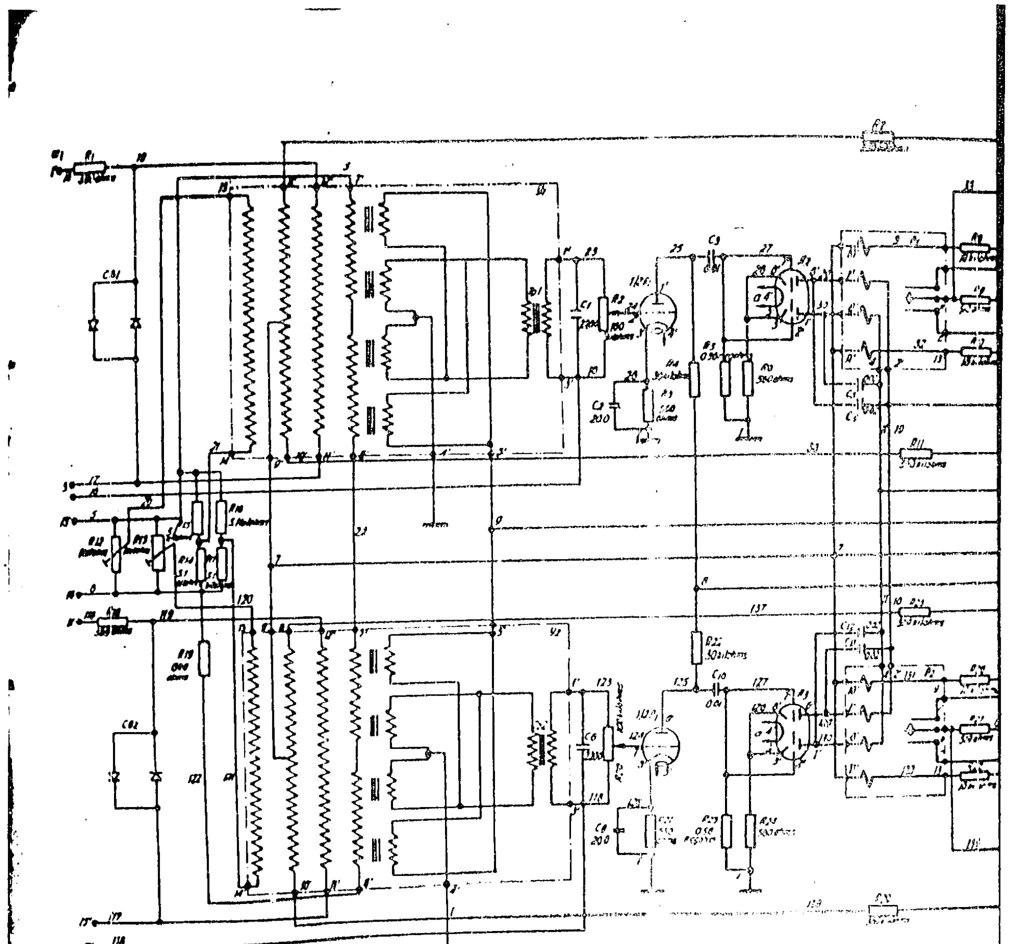

FIG.29. ELECTRON RELAY DIAGRAM

Схема электронного реле

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NO FOREIGN DISSEM

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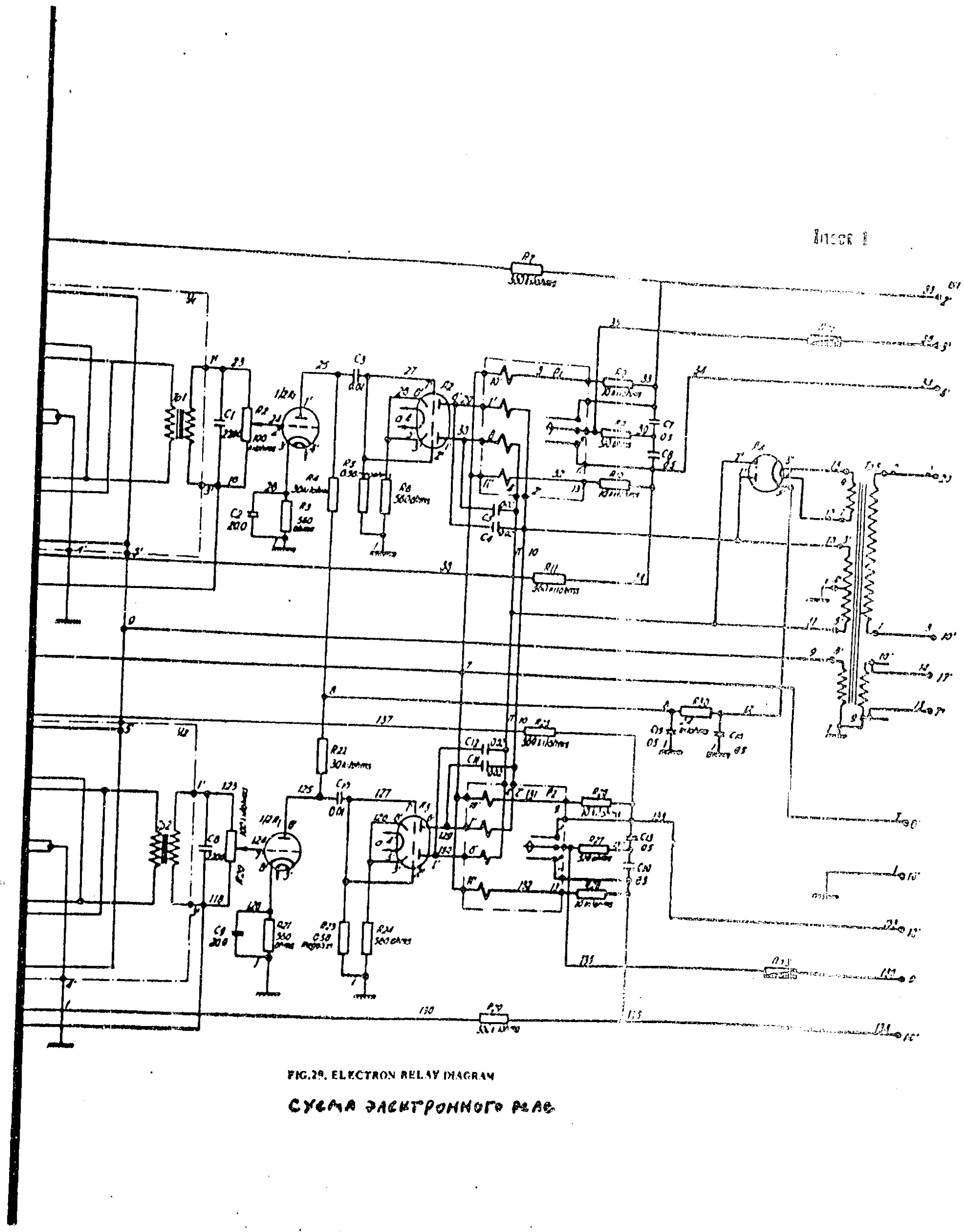


FIG.29. ELECTRON RELAY DIAGRAM

СХЕМА ЭЛЕКТРОННОГО РЕЛЕ

SECRET
NO FOREIGN DISSEM

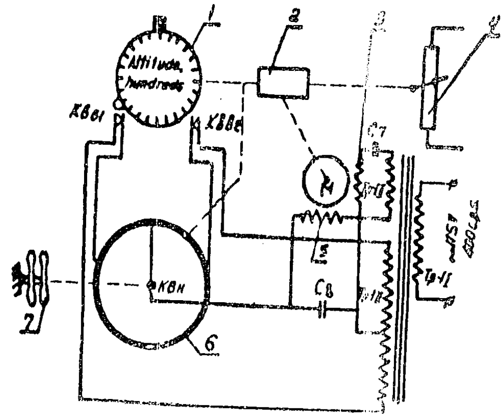
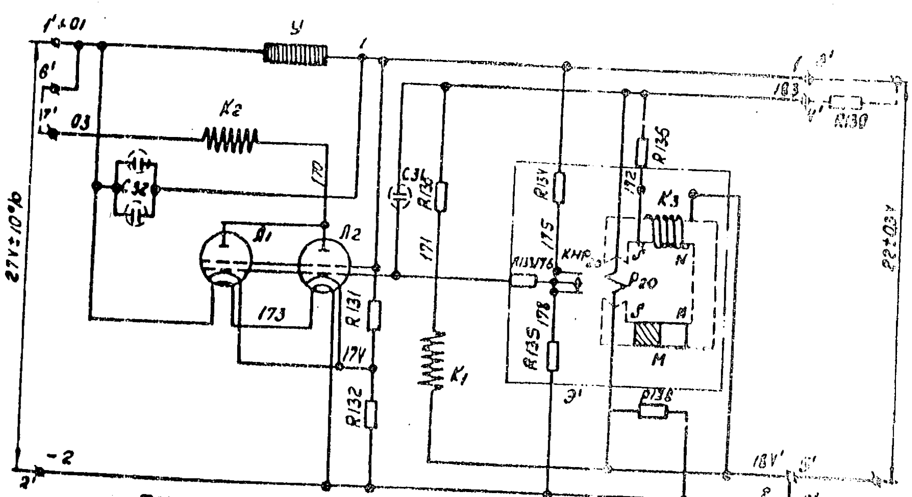


FIG.30. ALTITUDE FOLLOW-UP DIAGRAM

1 - altitude scale; 2 - reduction unit; 3 - electric motor excitation coil; 4 - altitude transmitting potentiometers; 5 - electric motor control winding; 6 - disk with contact half-rings; 7 - aneroid capsules.

Схема отработки высоты



Принципиальная схема стабилизатора напряжения СН-4

FIG.31. KEY ELECTRICAL DIAGRAM OF VOLTAGE REGULATOR CH-4

У - regulator carbon pile; K_1 - carbon regulator main coil; K_2 - carbon regulator additional coil; $Л_1$ and $Л_2$ - electron valves; R_{131} - fixed resistor, 56 ohms; R_{132} - fixed resistor, 25 ohms; C_{31} - electrolytic capacitor C=200 μF; C_{32} - electrolytic capacitor C=2x200-400 μF; R_{130} - fixed resistor, 56 ohms; R_{133} - fixed resistor, 500 ohms; R_{134} - fixed resistor, 2000 ohms; R_{135} - fixed resistor, 500 ohms; R_{136} - thermo-compensating resistor, 29.25 ohms; R_{138} - fixed resistor, 3300 ohms; R_{139} - compensating resistor, 1.7 ohms; $КНР_{20}$ - frame contacts; P_{20} - relay frame; K_3 - electromagnet winding; Э - magnetic screen of the sensitive element.

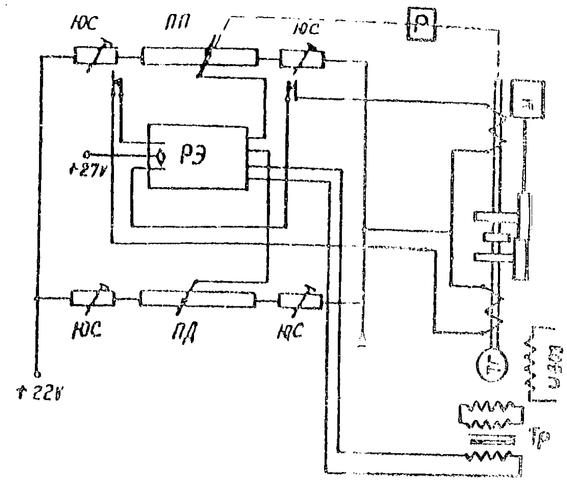
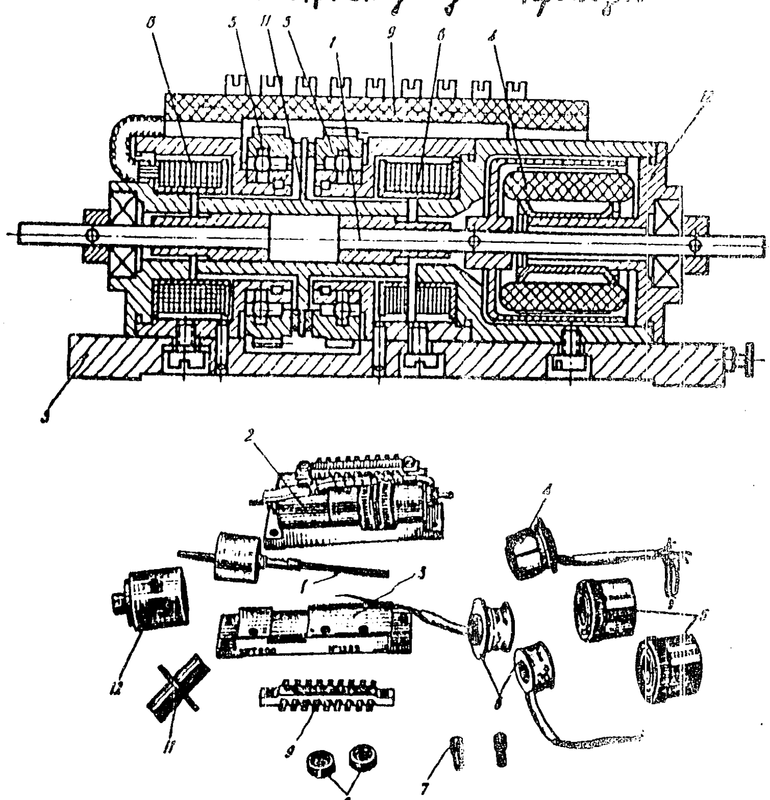


FIG.32. BLOCK DIAGRAM OF FOLLOW-UP DRIVE

Блок-схема следящего привода.



Эл. магнитная муфта

FIG.33. REVERSIBLE ELECTROMAGNETIC CLUTCH ЭРТ-200

1 - axle with tacho-generator sleeve; 2 - general view; 3 - base plate; 4 - tacho-generator windings; 5 - driving gears; 6 - electromagnet coils; 7 - bush; 8 - ball bearings; 9 - terminal block; 10 - shims; 11 - armature with disk; 12 - tacho-generator housing.

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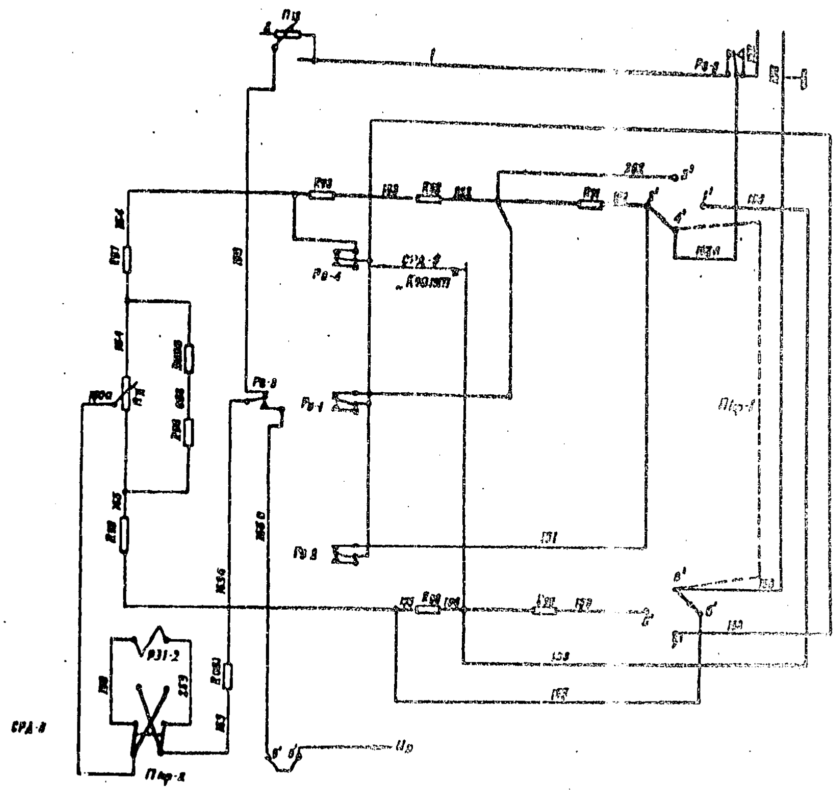

FIG.34. RANGE FOLLOW-UP KEY DIAGRAM

Сх. отработки дальности

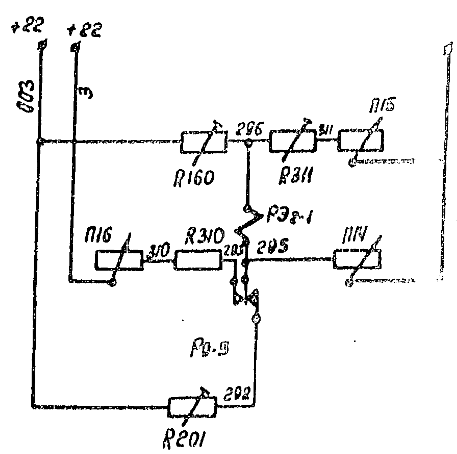

FIG.35. DIAGRAM OF RETICLE CIRCLE BRIDGE

Сх. Моста цепи

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50X1-HUM

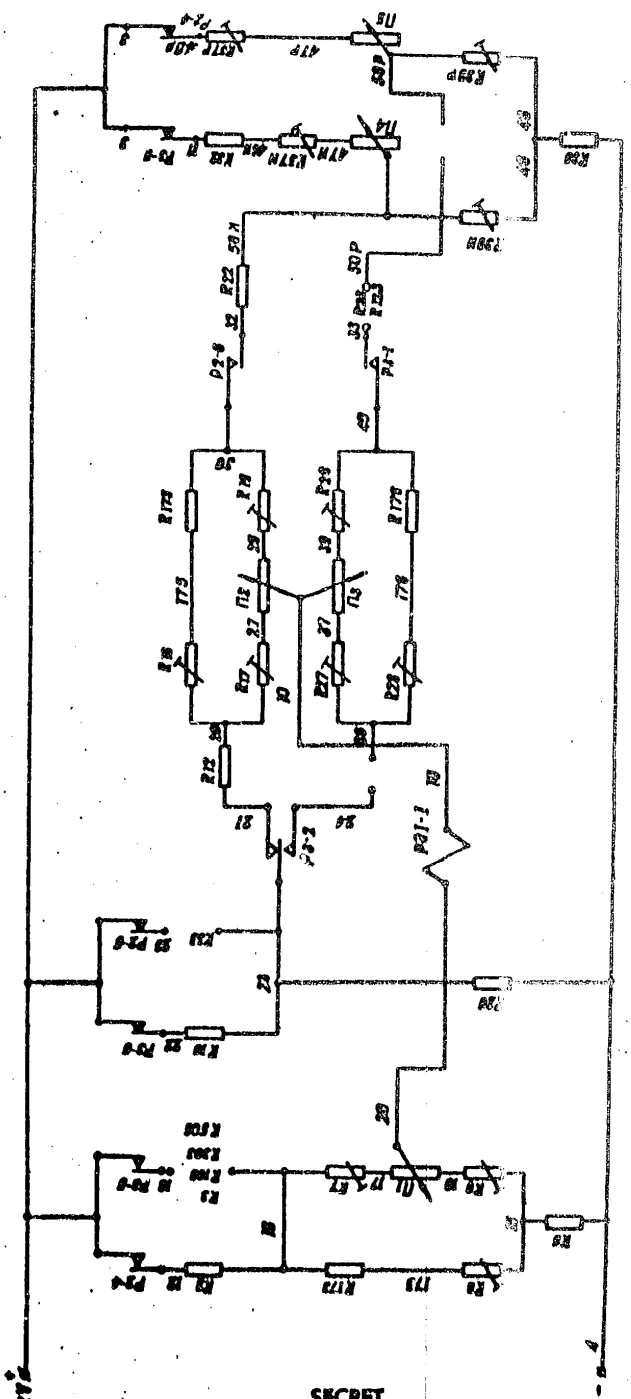

FIG. 35. BALLISTICAL BRIDGE DIAGRAM

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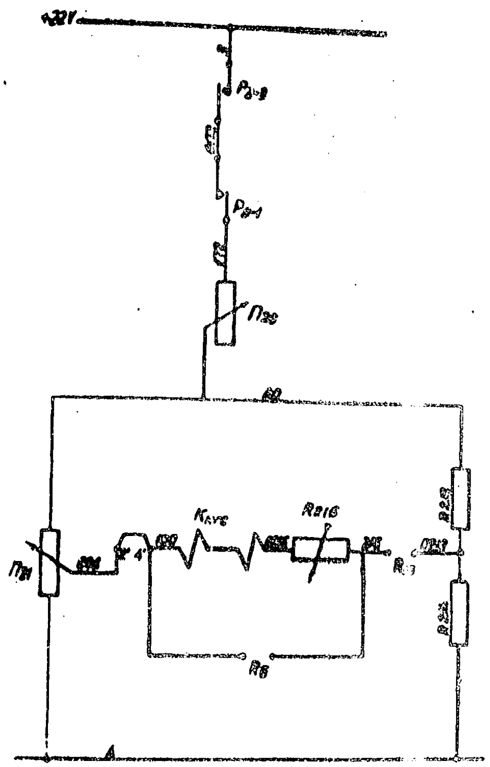

FIG. 37. KEY DIAGRAM OF PLOTTING HORIZONTAL COMPONENT OF AIRCRAFT SLIP CORRECTION

Пр. сх. построения горизонтальной составляющей поправки на скольжение.

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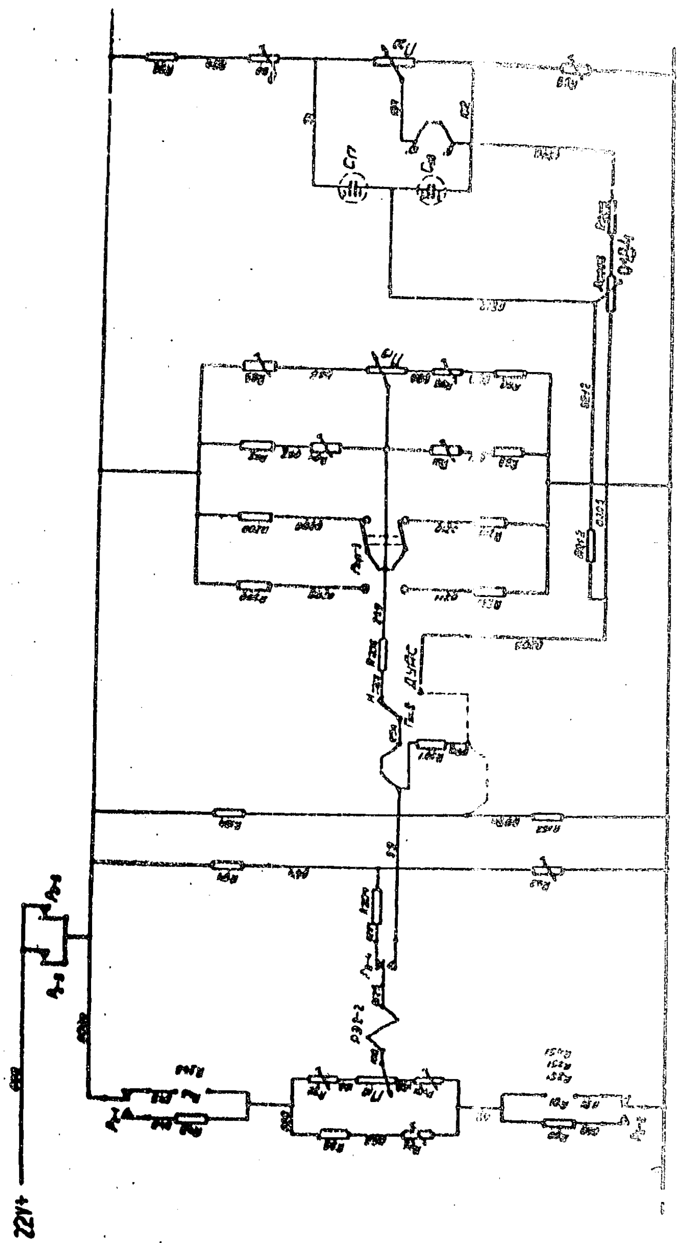

FIG.33. KEY DIAGRAM OF PLOTTING VERTICAL COMPONENT OF AIRCRAFT FIELD CORRECTION

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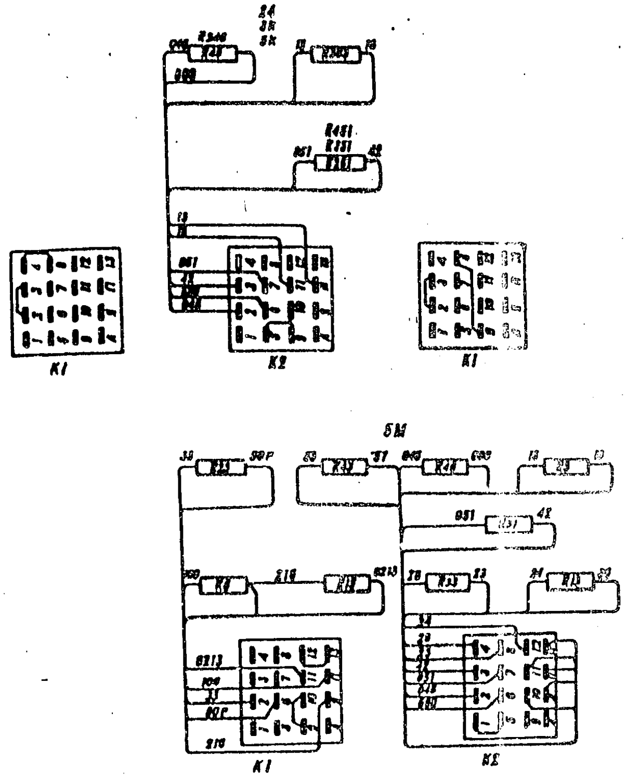

эл. сх. баллистического узла

FIG.39. ELECTRICAL DIAGRAM OF BALLISTICAL UNITS

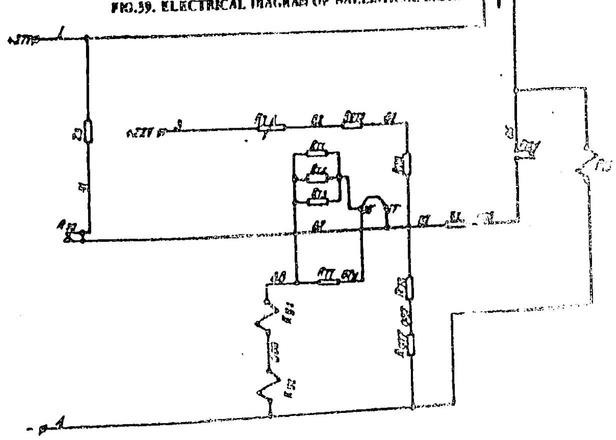

FIG.40. DAMPING CIRCUIT DIAGRAM

сх. цепи демпфирования.

50X1-HUM

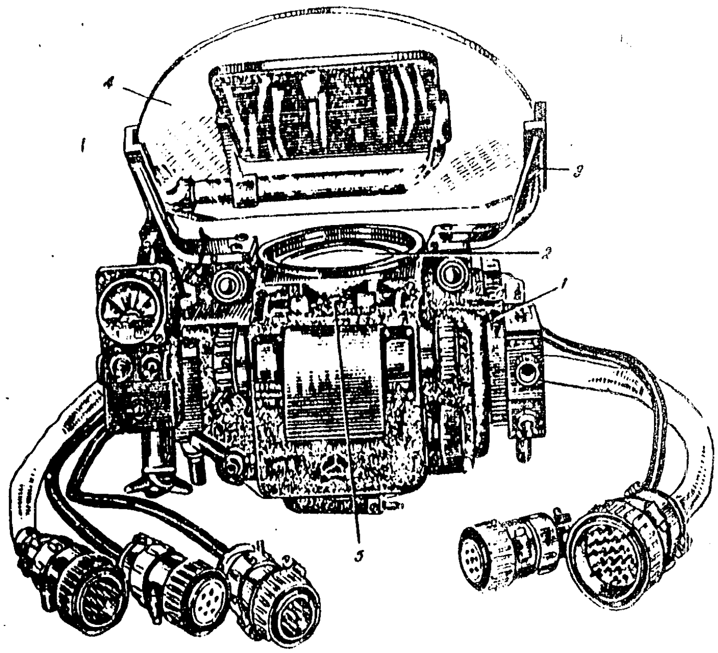

FIG.41. SIGHT HEAD ON BRACKET WITH LIGHT FILTER
1 - housing; 2 - objective; 3 - reflector bracket; 4 - reflector; 5 - adjusting screw.

Головка прицела на кронштейне
со светофильтром.

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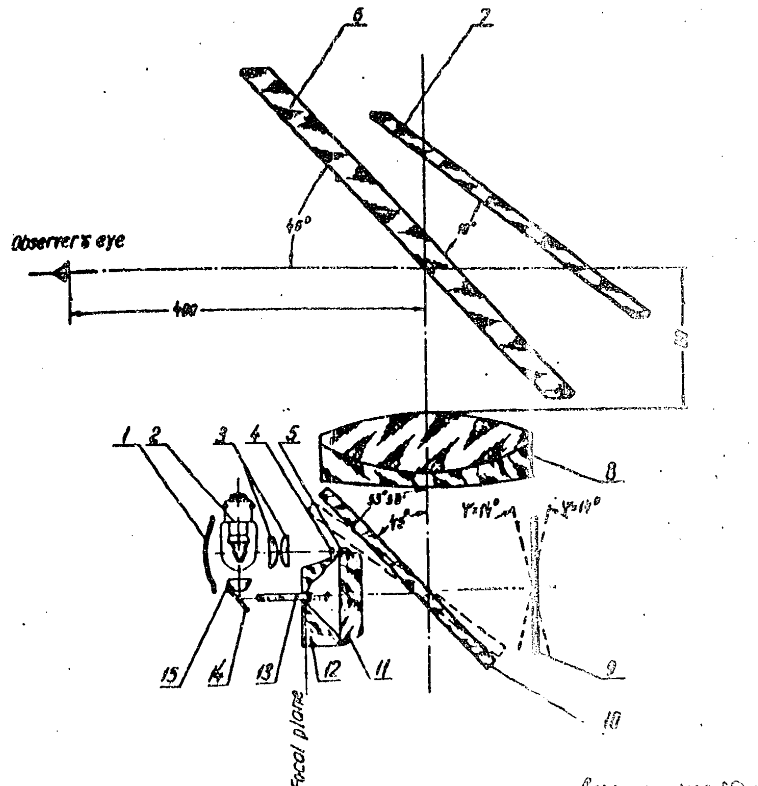
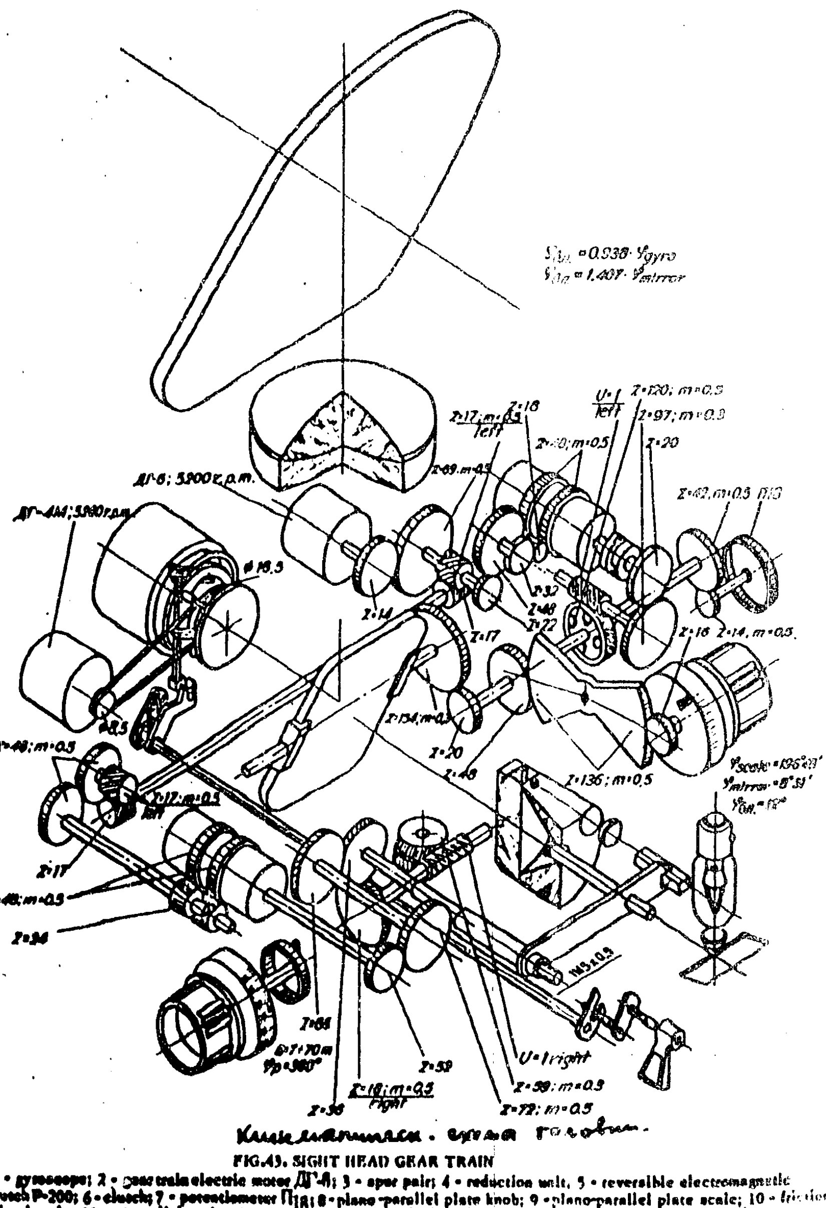


оптическ. система головки прицела

FIG.42. SIGHT HEAD OPTICAL SYSTEM

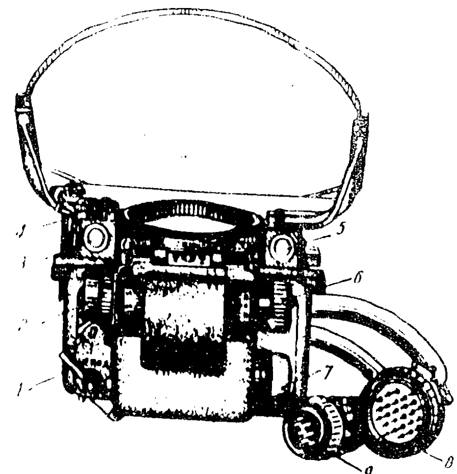
1 - metal reflector; 2 - light source; 3 - plano-convex condenser lenses; 4 - glass plate with transparent pip; 5 - small right-angle prism; 6 - reflecting prism; 7 - diffusing glass light filter; 8 - two-lens objective; 9 - gyro mirror; 10 - plano-parallel plate (semi-silvered mirror); 11 - plano-parallel plate with reflecting edge; 12 - mirror cone; 13 - light tube; 14 - mirror; 15 - plano-convex condenser lens.



Кинематическая схема головки.

FIG.43. SIGHT HEAD GEAR TRAIN

1 = gyroscope; 2 = gear train electric motor ДГ-6; 3 = spur pair; 4 = reduction unit; 5 = reversible electromagnetic clutch P-200; 6 = clutch; 7 = potentiometer П18; 8 = plano-parallel plate knob; 9 = plano-parallel plate scale; 10 = friction clutch axle; 11 = glass light tube; 12 = motion screw; 13 = locking lever; 14 = nut; 15 = worm pair; 16 = axle; 17 = potentiometer П14; 18 = base setting scale; 19 = base setting knob; 20 = reversible electromagnetic clutch 2ПТ-200; 21 = worm pair; 22 = potentiometer П18; 23 = worm and wheel pair; 24 = plano-parallel plate; 25 = spur pair; 26 = spring unit; 27 = gyro electric motor ДГ-4М.



головка прицела.

FIG.44. SIGHT HEAD

1 - sight head gyro locking lever, 2 - base setting knob, 3 - signal lamp LOCK ON, 4 - block, 5 - signal lamp COME OFF; 6 - plano-parallel plate knob, 7 - reticle illumination rheostat knob; 8 - connector ШР-2; 9 - connector ШР-1.

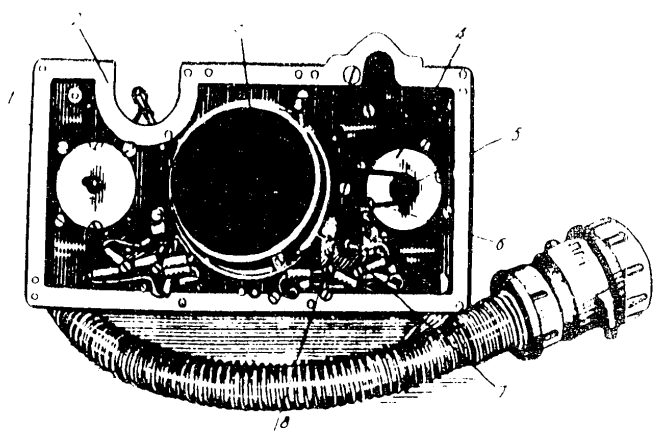


FIG.45. SIGHT HEAD FRONT COVER (INNER VIEW)

1 - gear train electric motor ДГ-6, 2 - front cover, 3 - gyro unit, 4 - gyro unit electric motor ДГ-6М, 5 - pulley, 6 - spring belt, 7 - block, 8 - roller.

передн. крышка головки прицела (вид внутри)

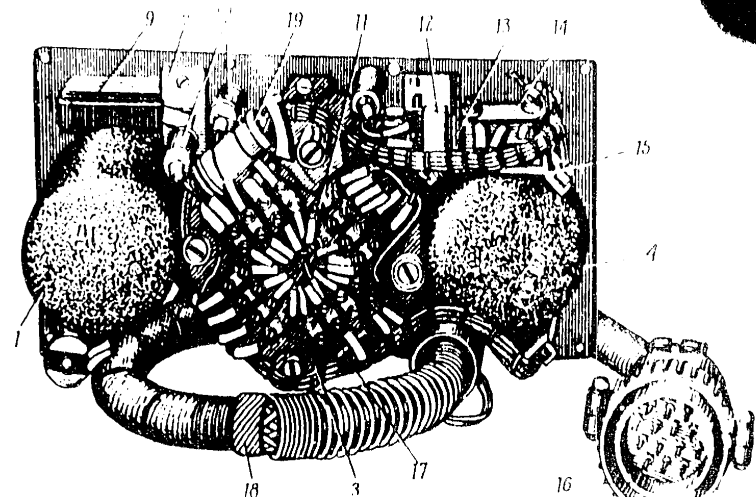
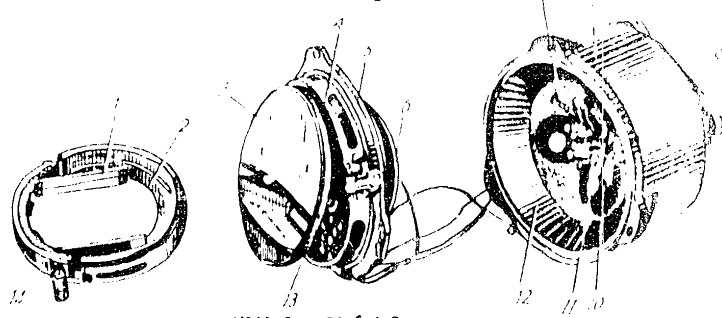


FIG. 46. SIGHT HEAD FRONT COVER (EXTERIOR VIEW)

1 - gear train electric motor [illegible]; 2 - front cover; 3 - gyro unit; 4 - gyro unit electric motor [illegible]; 9 - heater relay [illegible]; 10 - [illegible] capacitors; 11 - block; 12 - fixed resistor; 13 - angle bar; 14 - adjusting resistor [illegible]; 15 - nine-terminal block; 16 - connector ШР-1; 17 - spark-quenching resistor [illegible]; 18 - cable with connector ШР-1; 19 - sparkquenching capacitor [illegible].

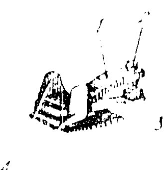
передн. крышка головки пр.
(внешний вид)



узел гироскопа

FIG. 47. GYRO UNIT (EXPLODED VIEW)

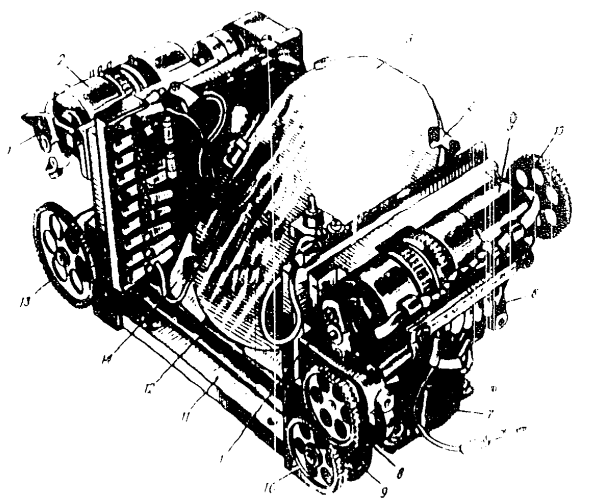
1 - four-bar mechanism; 2 - lever; 3 - rotating mirror; 4 - ring; 5 - gyro cover; 6 - spherical dome; 7 - thermoregulator; 8 - gyro housing; 9 - bushing; 10 - coil; 11 - core; 12 - brass [illegible]; 13 - mirror mounting; 14 - lock axle with carrier.



терморегулятор

FIG. 48. THERMOREGULATOR

1 - bracket; 2 - adjusting screw with contact; 3 - bimetallic plate; 4 - plates to solder current-conducting wires.



Узел плоско-параллельной пластины.

FIG. 39. PLANO-PARALLEL PLATE UNIT

1 - brakes of electromagnetic clutches P-200 and 2PT-200, 2 - reversible electromagnetic clutch P-200, 3 - plano-parallel plate, 4 - angle bar, 5 - reversible electromagnetic clutch 2PT-200, 6 - reversible drive of clutch 2PT-200, 7 - [illegible] transformer of reticle circles, 8, 9 - worm gears, 10 - gear, 11 - housing, 12 - shaft, 13 - input gear, 14 - balance weight, 15 - output gear

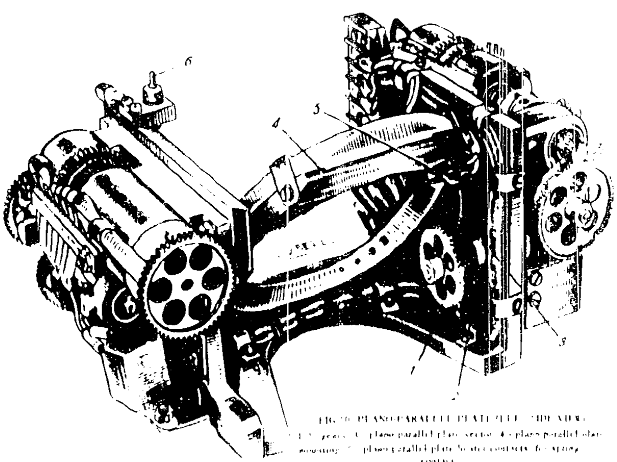


FIG. 40. PLANO-PARALLEL PLATE UNIT (SIDE VIEW)

1, 2 - gears, 3 - plano-parallel plate sector, 4 - plano-parallel plate mounting, 5 - plano-parallel plate [illegible] contacts, 6 - spring contact

Плоско-паралл. пластина
(левая сторона)

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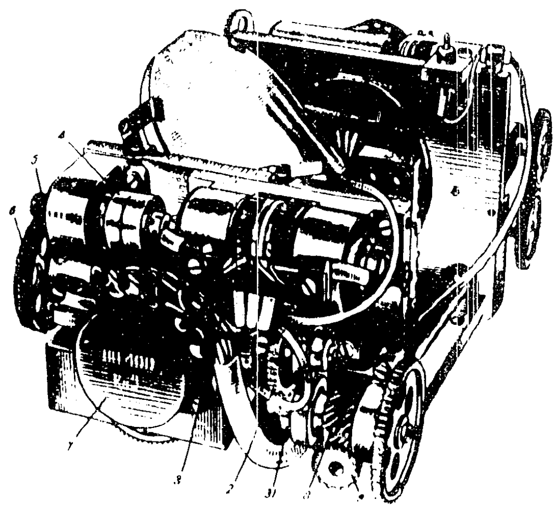
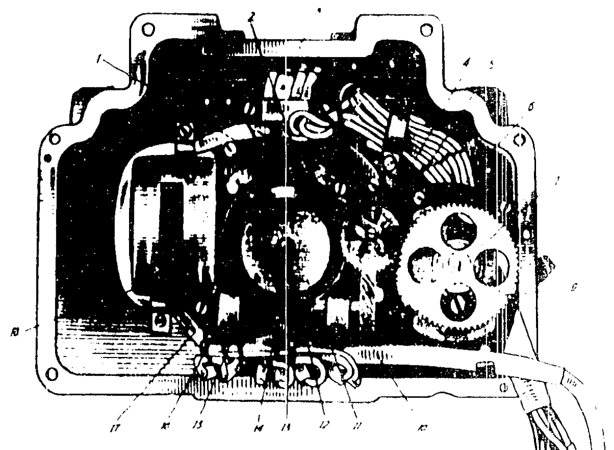


прав. - сторо.

FIG. 51. PLANO-PARALLEL PLATE (RIGHT-SIDE VIEW)
1,2 - spur gears, 3 - reversible drive of electromagnetic clutch P-300, 4 - cam coupling, 5,6 - spur gears, 7 - potentiometer $П_{18}$



задн. крышка

FIG. 52. REAR COVER
1 - mirror cone mounting, 2 - spring-loaded mounting, 3 - rear cover, 4,10 - screw gears, 5 - motion screw, 6 - bracket, 7 - [illegible], 8,9,13 - gears, 11 - mirror cone, 12 - glass light tube, 14 - receiving potentiometer [illegible], 15 - glass plano-parallel plate, 16 - bracket, 17 - worm, 18 - sector

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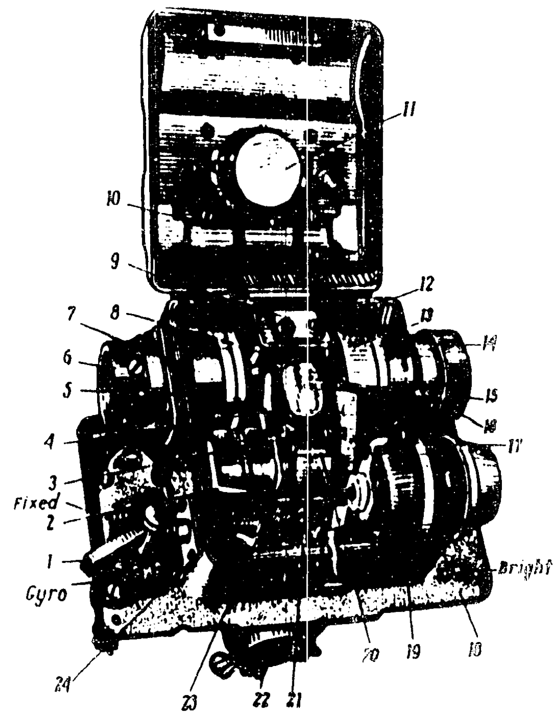

FIG.53. REAR COVER (BACK VIEW)

1 - locking lever; 2 - angle bar; 3 - cone mounting; 4 - block; 5 - transmitting potentiometer Π_{14}; 6 - base knob; 7 - base scale; 8 - bracket; 9 - throw-out bracket; 10 - springs; 11 - reflecting plate; 12 - adjusting screws; 13 - bracket; 14 - plano-parallel plate angle scale; 15 - lamp CM-46; 16 - plano-parallel plate tilting knob; 17 - sector; 18 - cover; 19 - dimmer rheostat; 20 - mirror; 21 - bracket; 22 - receiving potentiometer Π_{16}; 23 - condenser lens mounting; 24 - microswitch.

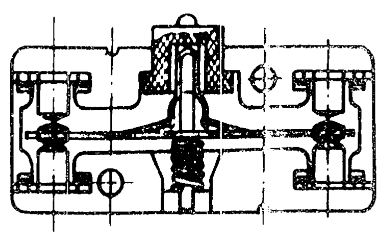

FIG.54. MICROSWITCH KB-5-2. SECTIONAL VIEW

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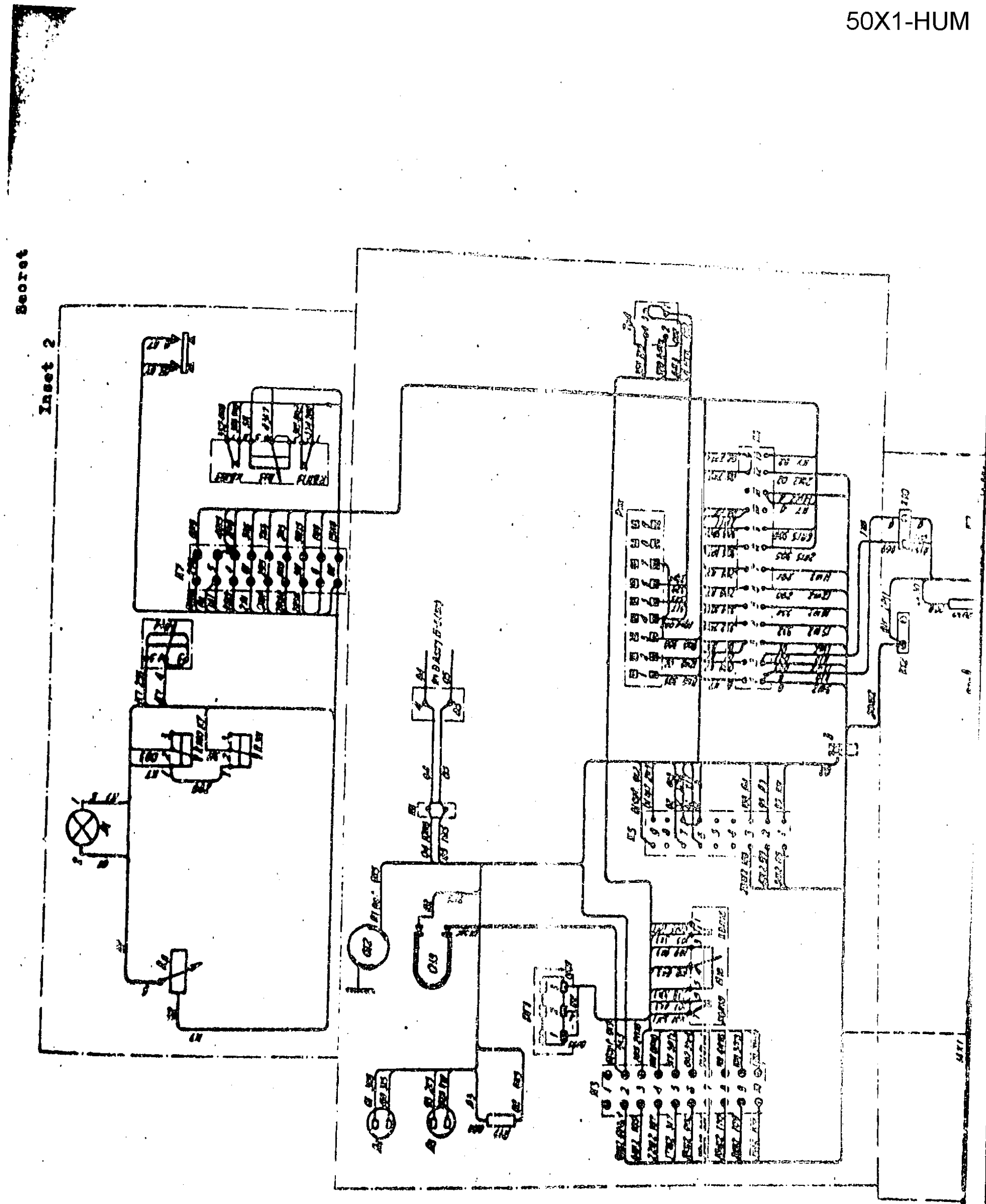

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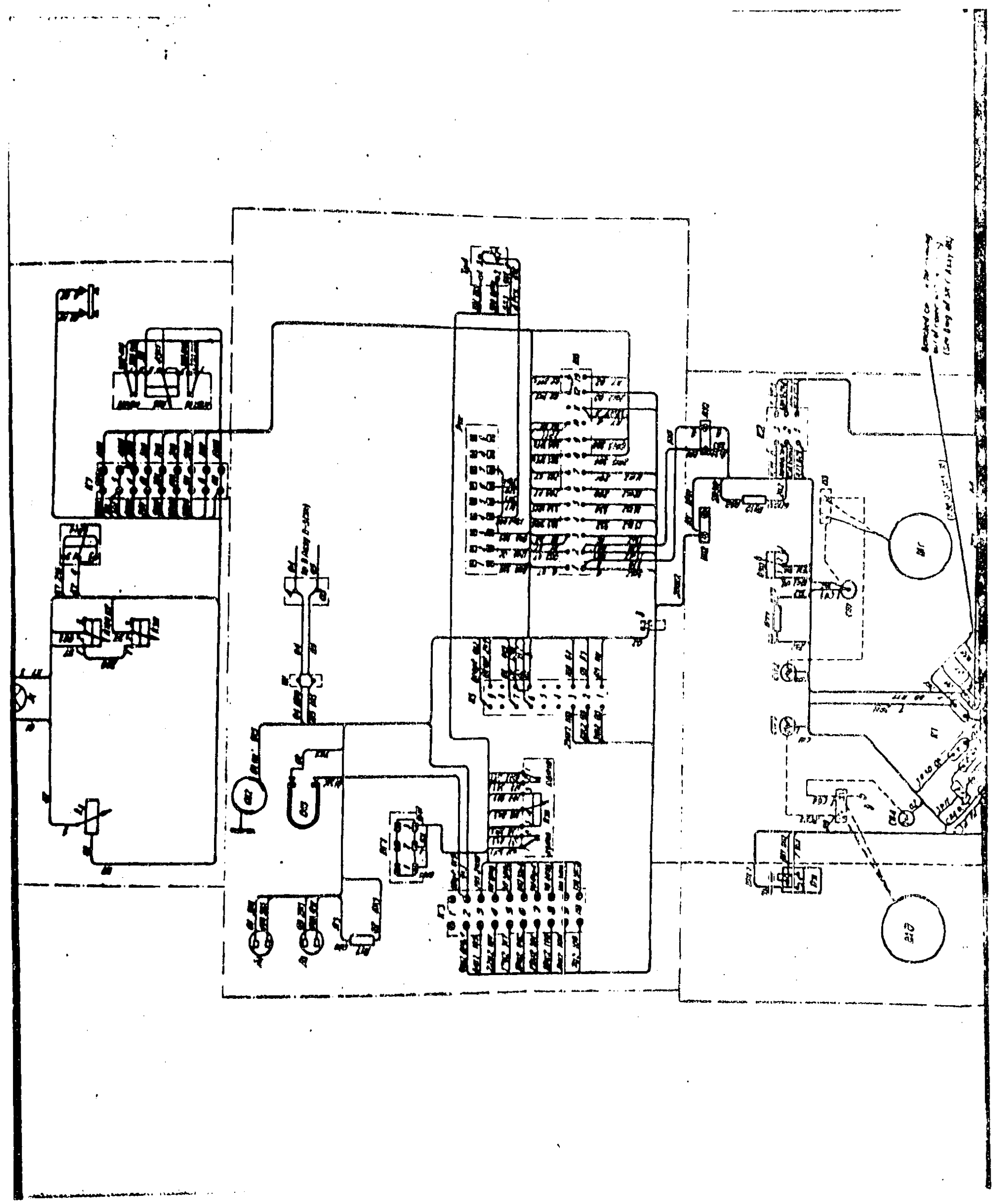
50X1-HUM



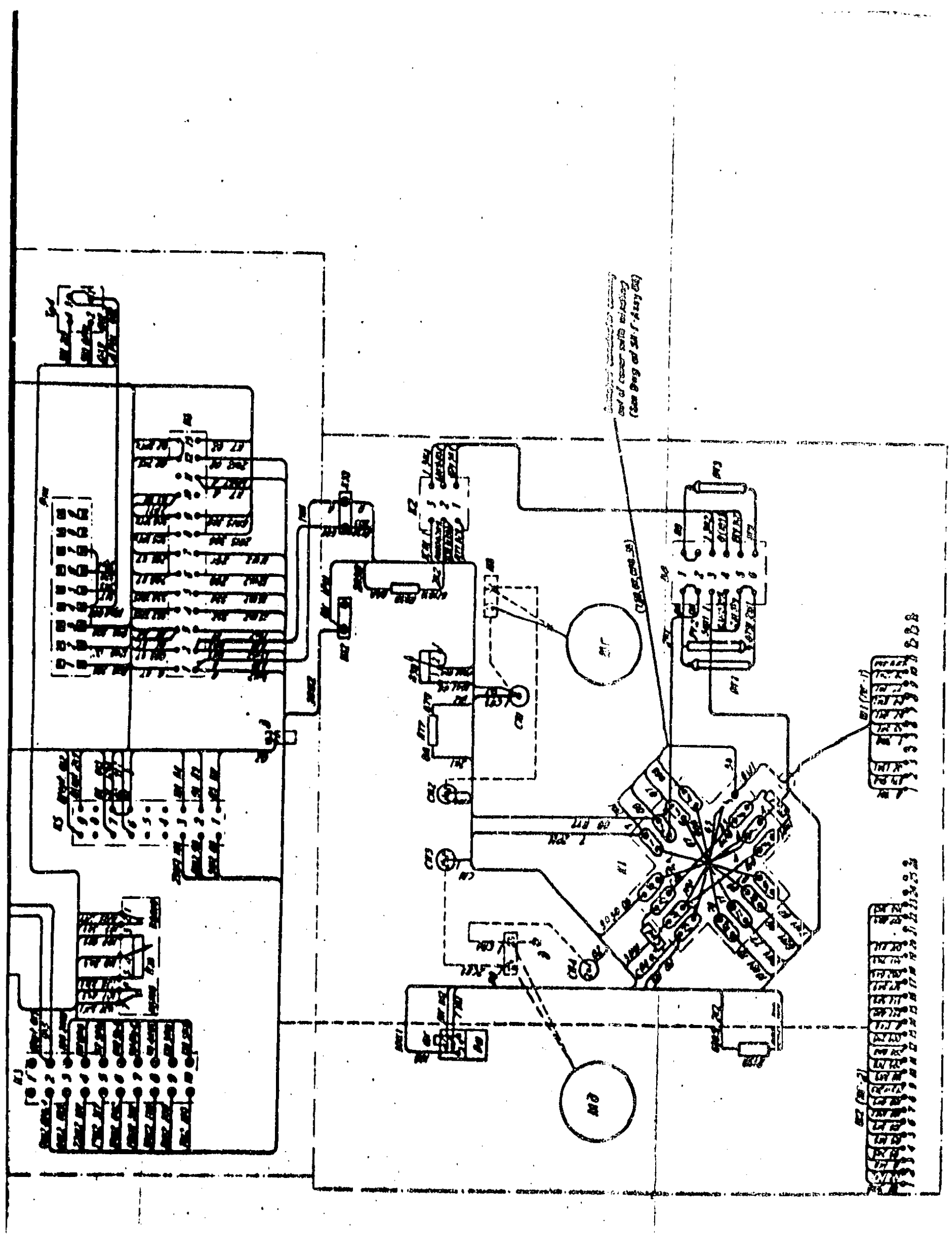


FIG. 35. SIGHT HEAD WIRING DIAGRAM

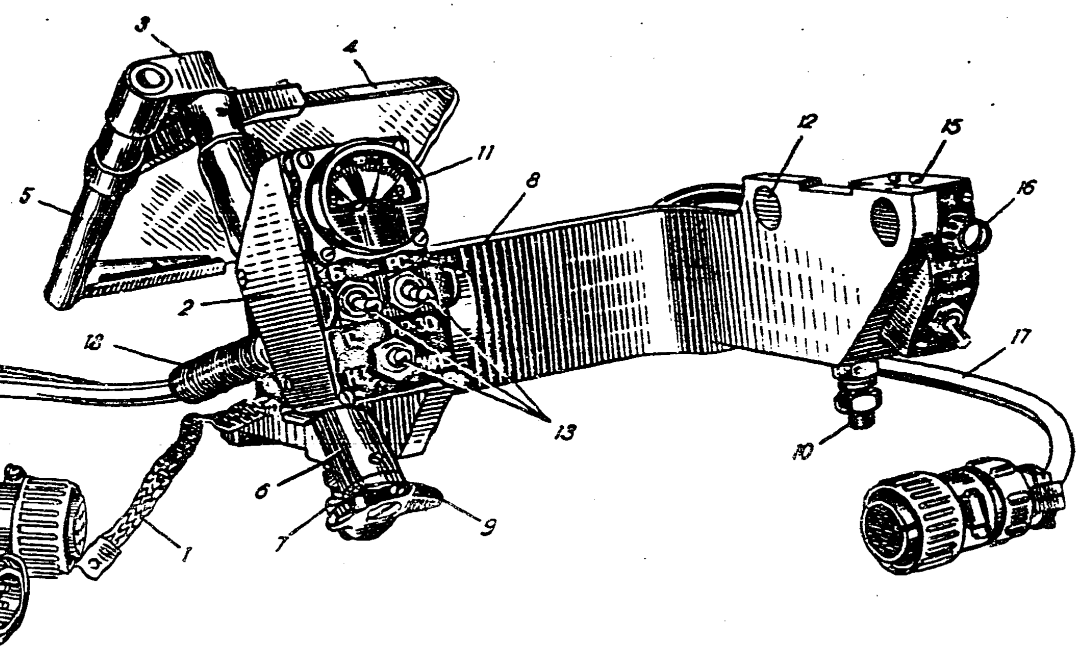


FIG.56. BRACKET WITH LIGHT FILTER

1 - bonding wire; 2 - light filter bracket; 3 - adapter bracket; 4 - light filter; 5 - rod; 6 - Lock; 7,10 - pins; 8 - bracket; 9 - knob; 11 - range indicator; 12 - steel plugs; 13 - selector switches; 15 - housing; 16 - signal lamp; 14,17 - cables; 18 - wire binding.

NO FOREIGN DISSEM

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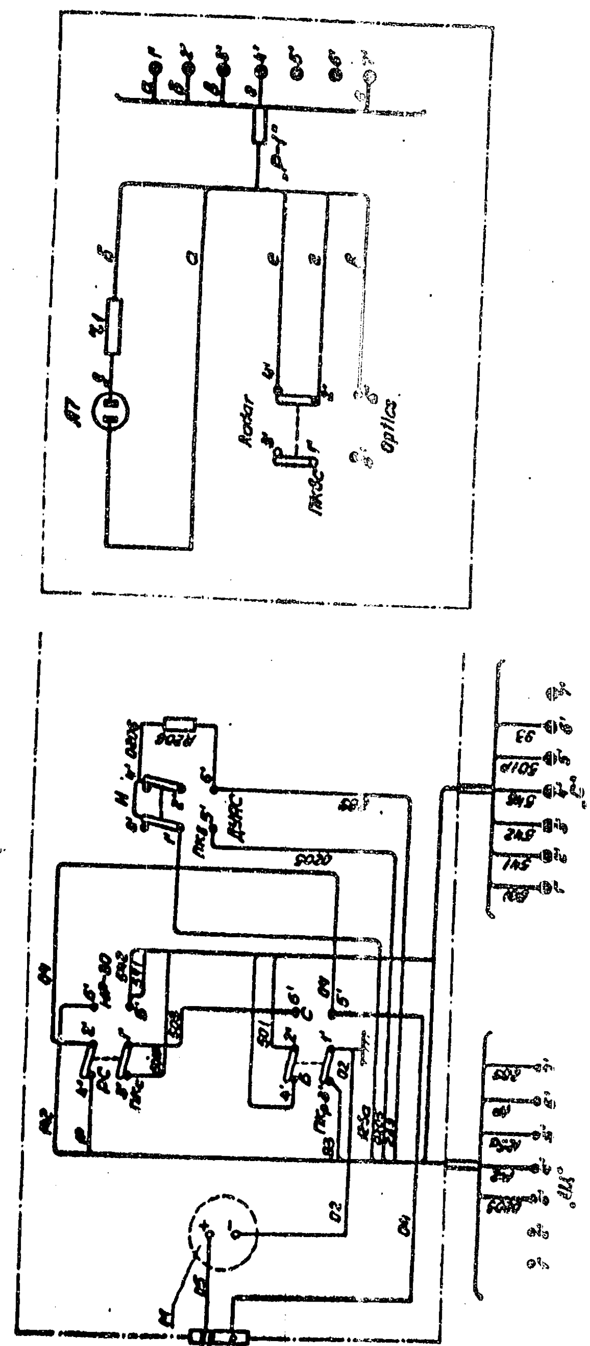

FIG.57. SIGHT HEAD BRACKET WIRING DIAGRAM

SECRET
NO FOREIGN DISSEM

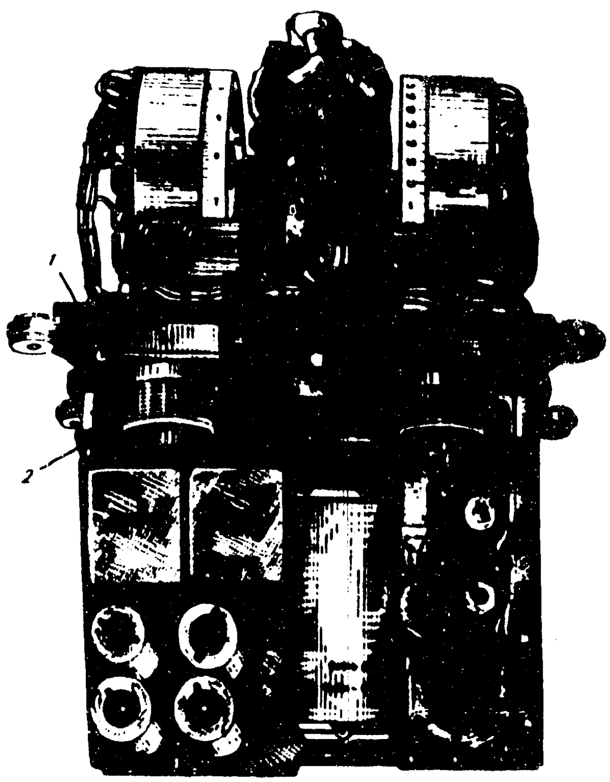

FIG.58. COMPUTER WITH ELECTRON RELAY WITHOUT JACKETS
1 - computer; 2 - electron relay.

Вычислитель с электронн. реле

50X1-HUM

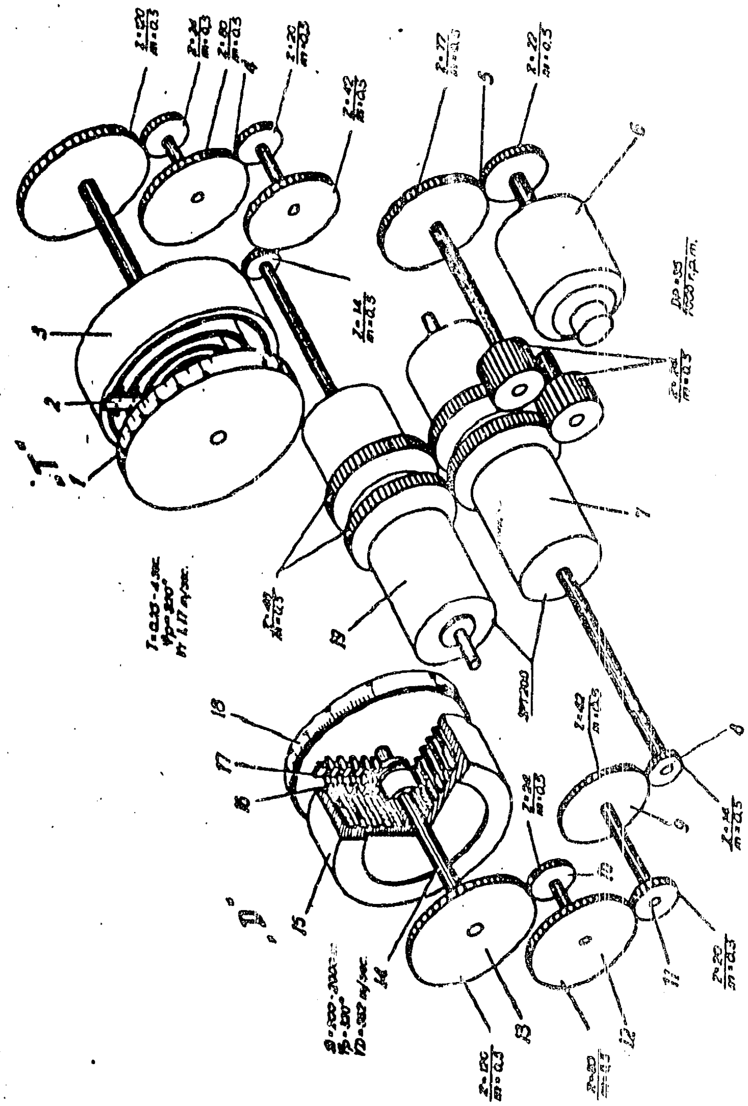

FIG.59. COMPUTER GEAR TRAIN

1 - indicated time scale; 2 - slider with brushes; 3,15 - potentiometer unit; 4 - spur reduction gear of time unit; 5 - gear pair; 6 - electric motor; 7 and 19 - reversible electromagnetic clutches; 8,9,10,11,12,13 - reduction gears of range unit; 14 - axle; 16 - brushes; 17 - slider; 18 - range scale.

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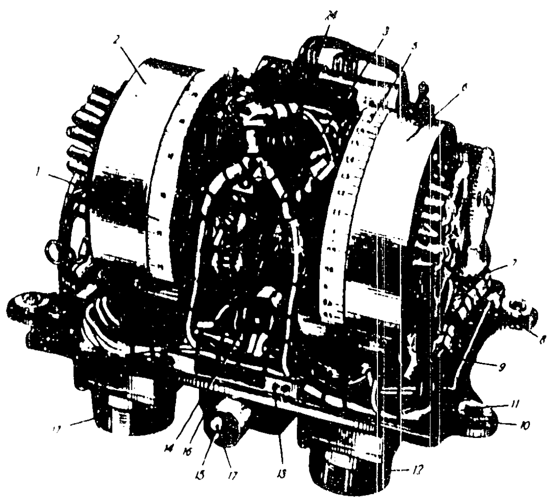
50X1-HUM



[illegible]

FIG. 60. COMPUTER (AS VIEWED FROM THE INSPECTION PORT SIDE)

1 - range scale, 2 - range follow-up potentiometer unit, 3 - strut, 4 - adjusting resistor, 5 - indicated time scale, 6 - indicated time follow-up potentiometer unit, 7 - angle bar, 8 - base plate, 9 and 13 - angle bars, 10 - rubber cycler, 11 - bushing, 12 and 17 - connector plugs, 14 - fixed resistors, 15 - sleeve, 16 - protective jacket, 17 - radar ranging unit selector switch [illegible]

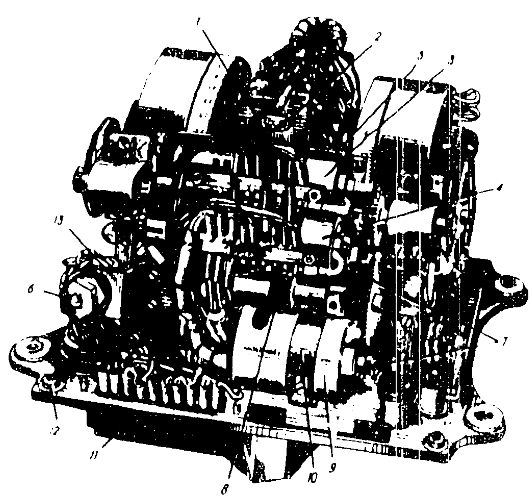
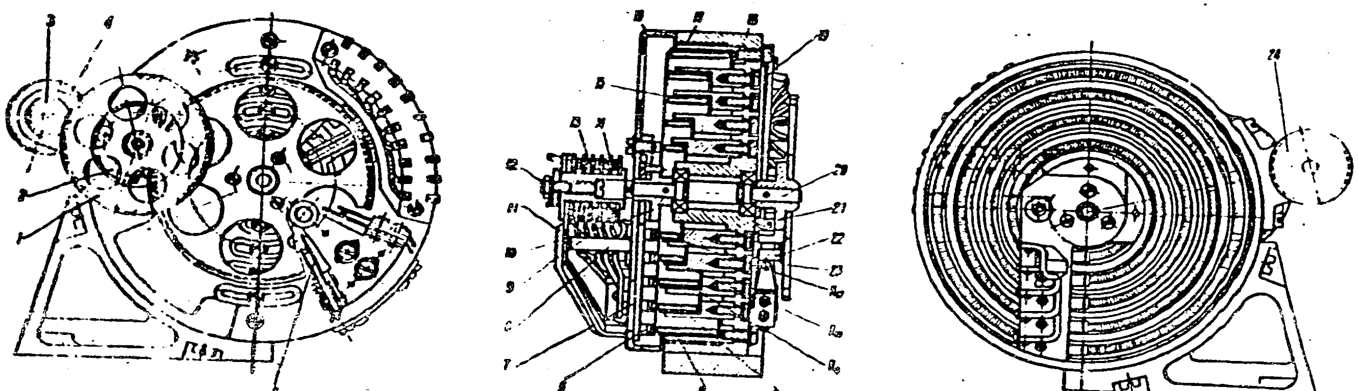


FIG. 61. COMPUTER (BACK VIEW) [illegible]

1, 11 - brackets, [illegible] - screws, 3 and 4 - reversible electromagnetic clutches, 5 - plate, 6 - high-ohmic resist[illegible], 7 and 8 - gear pairs, 9 - electric motor, 10 - [illegible] yoke, 11 - [illegible] connector, 12 - threaded bushing



Блок потенциометров-дальномера.

FIG.42. RANGE POTENTIOMETER UNIT

1 - double gear; 2 - screw with flange; 3 and 24 - gears; 4 - bracket; 5 - contact plates; 6 - brushes; 7 - slider; 8 - screw; 9 - terminals; 10 - bushing; 11 - bracket; 12 - nut; 13 - spiral springs; 14 - washers; 15 - potentiometer formers; 16 - range axle; 17 - bushing; 18 - cylindrical housing; 19 - terminal block; 20 - axle; 21 - bushing; 22 - limiting pin; 23 - driven gear; 25 - angle bar; П 4, П 5, П 11, П15, П 37 - potentiometers

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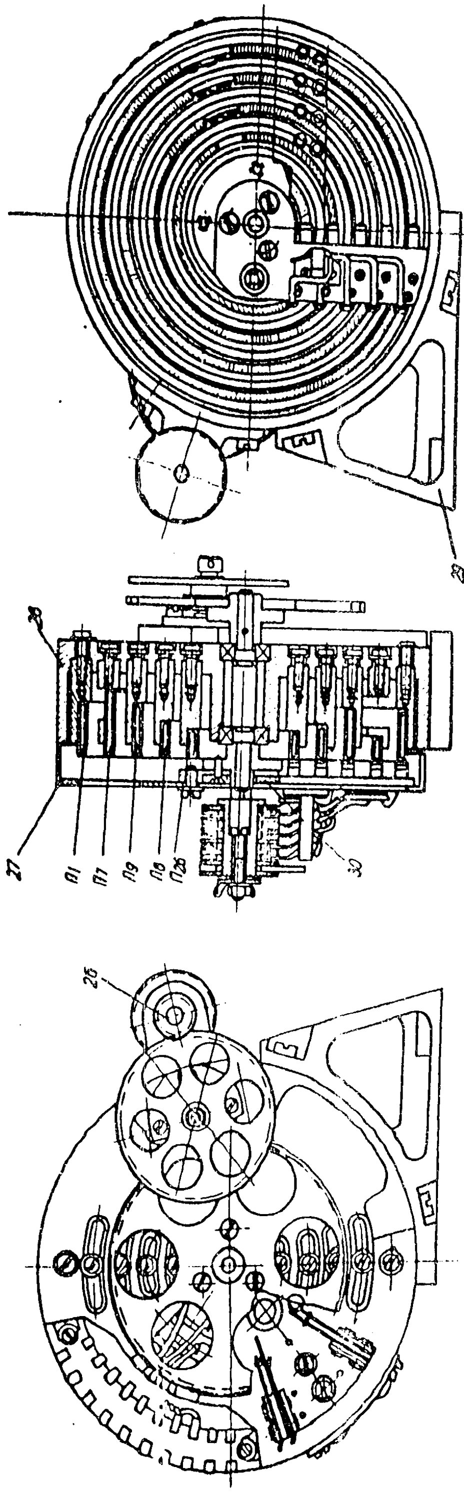
SECRET
NO FOREIGN DISSEM

50X1-HUM



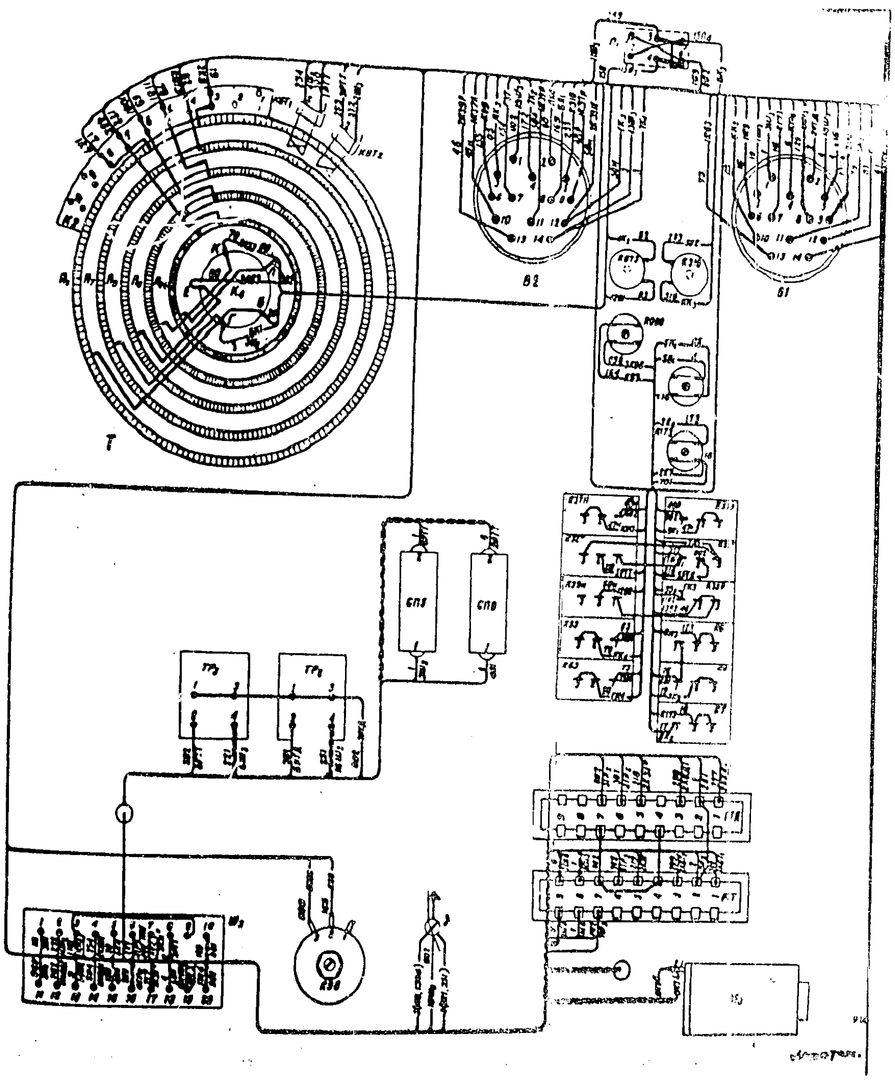
Блок потенциометров приборного времени

FIG.65. INDICATED TIME POTENTIOMETERS UNIT

26 - reduction unit; 27 - indicated time scale; 28 - cylindrical housing; 29 - angle bar; 30 - slider; П1, П26, П7, П9, П8 - indicated time potentiometers.

SECRET
NO FOREIGN DISSEM

50X1-HUM



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50X1-HUM

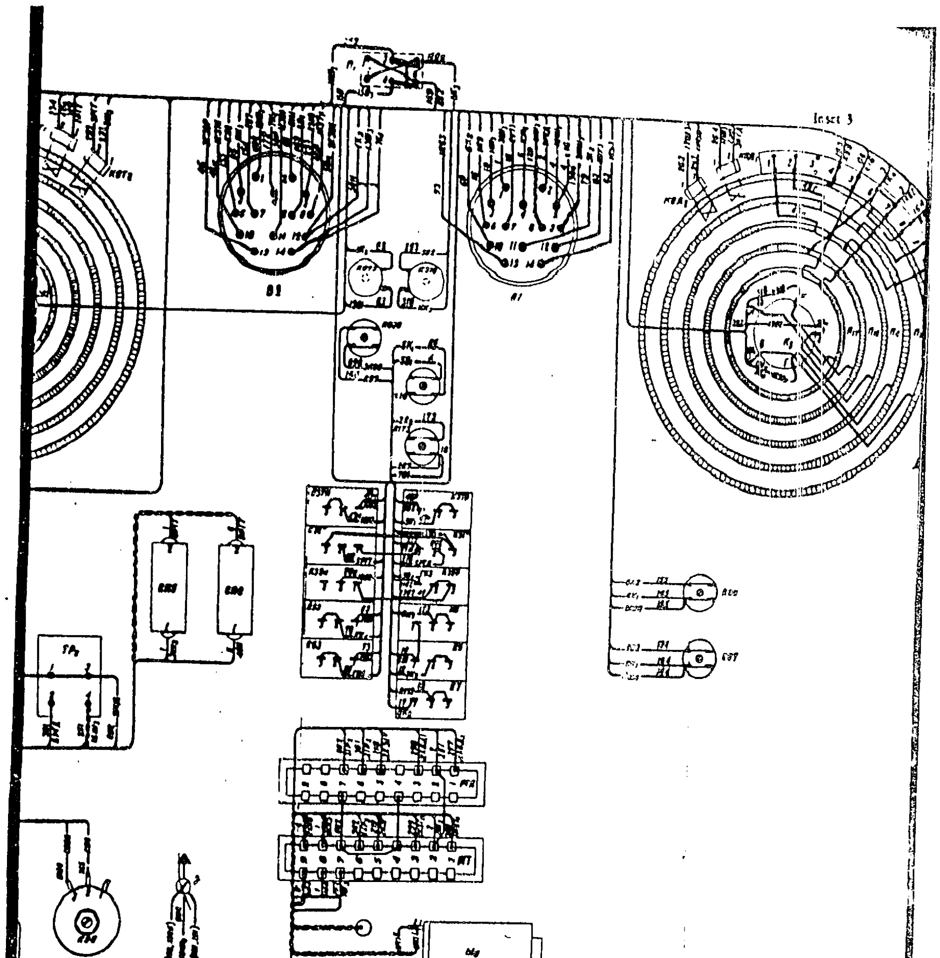

FIG. 4A. COMPUTER WIRING DIAGRAM

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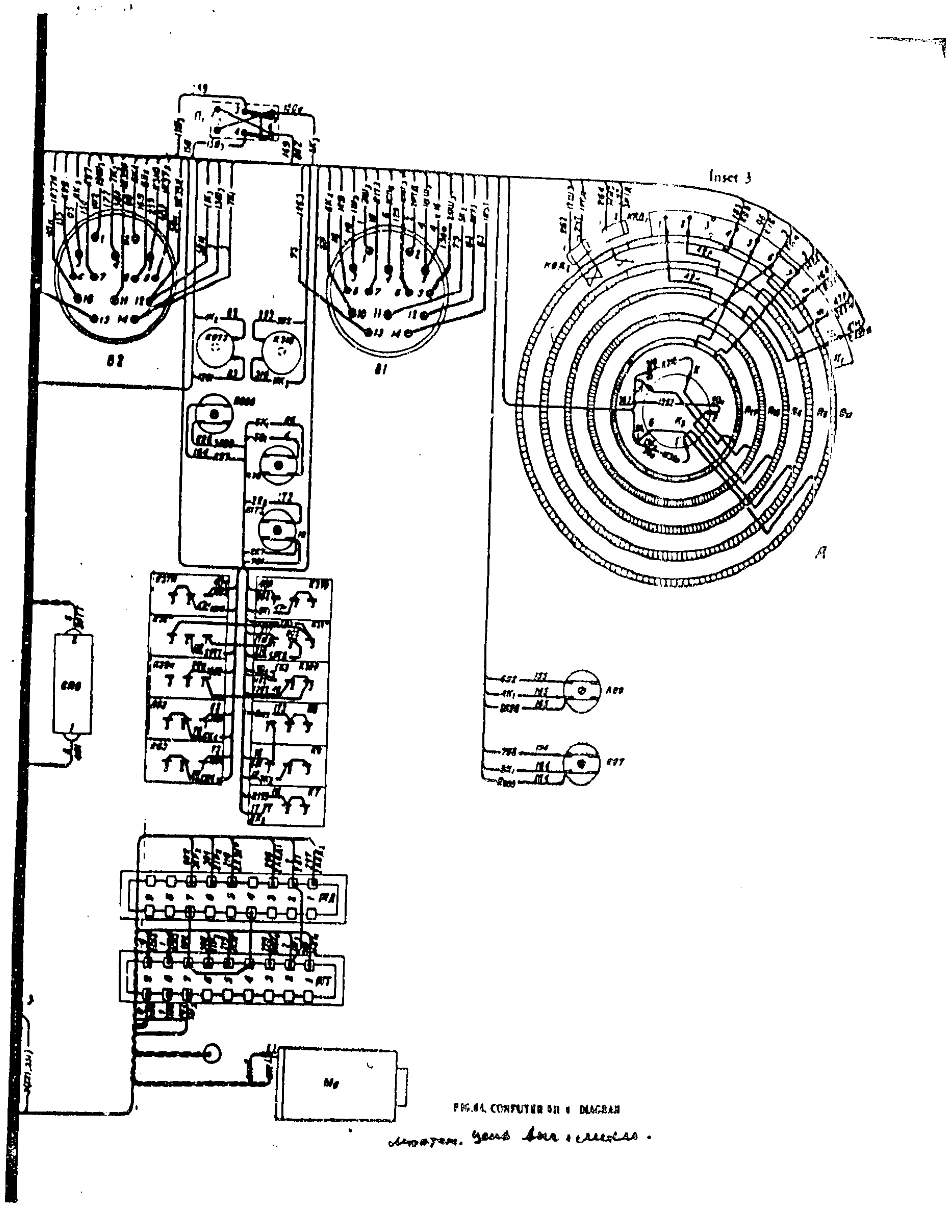
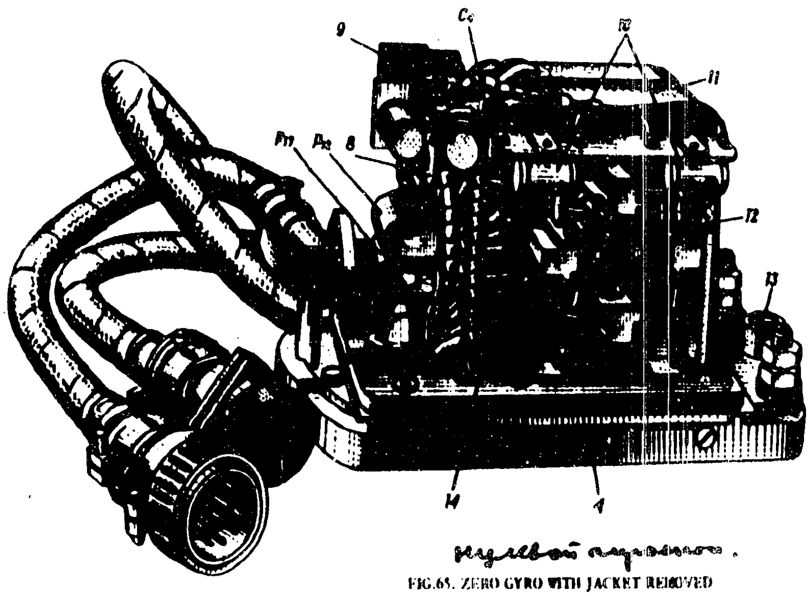


FIG. 64. COMPUTER [illegible] DIAGRAM



нулевой гироскоп.

FIG.65. ZERO GYRO WITH JACKET REMOVED

4 – base plate; 8 – bracket; 9 – adjusting resistors; 10 – capacitors; 11 – jacket; 12 – zero gyro; 13 – level; 14 – terminal block; P_{12} and P_{17} – heater relay; C_4 – electric motor capacitor.

50X1-HUM

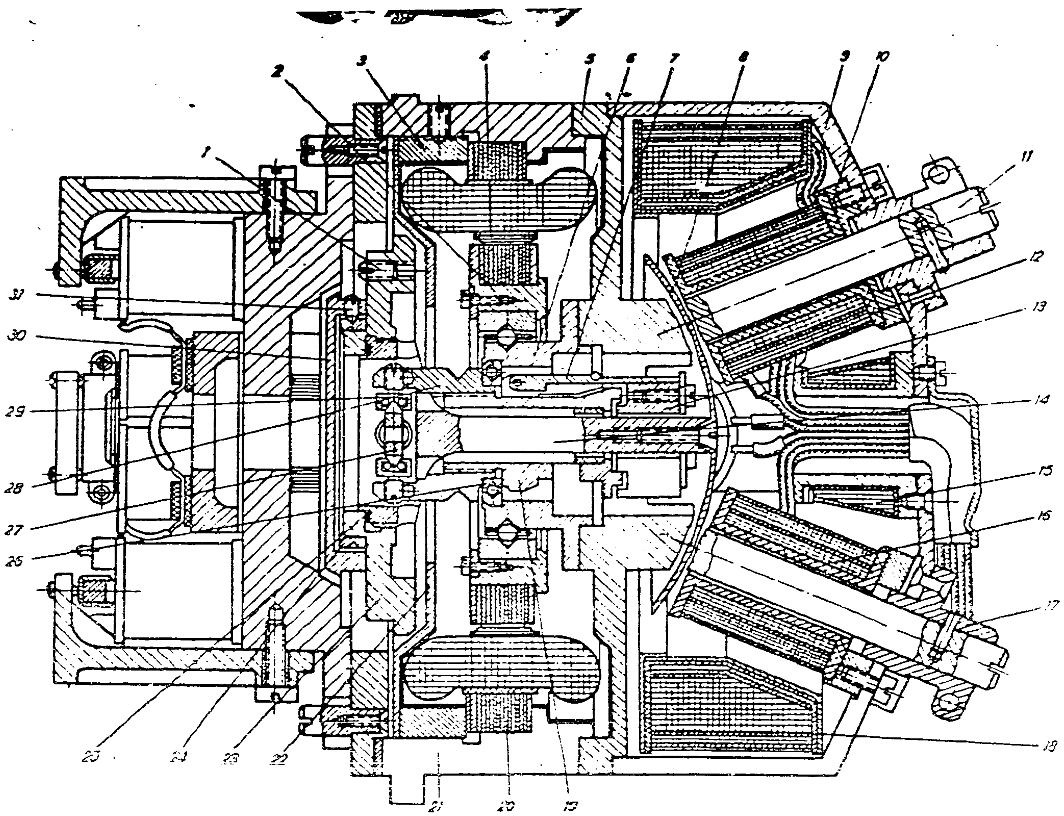


FIG.66. ZERO GYRO CONSTRUCTION

1 - balance screw; 2 - bushing; 3 - ring; 4 - rotor; 5 - cover; 6 - bushing; 7 - rod; 8 - aluminium dome, 9 - housing, 10 - flange; 11 - core, 12 - roller, 13 - weight; 14 - axle; 16 - correction coil, 17 - bushings; 18 - former, 19 - bushing, 20 - stator; 21 - base plate, 22 - screen, 23 - [illegible] 24 - [illegible], 25 - shim; 26 - bearing; 27 - gimbal, 28 - holder, 29 - bearing race, 30 - inductive transmitter armature, 31 - locking screw.

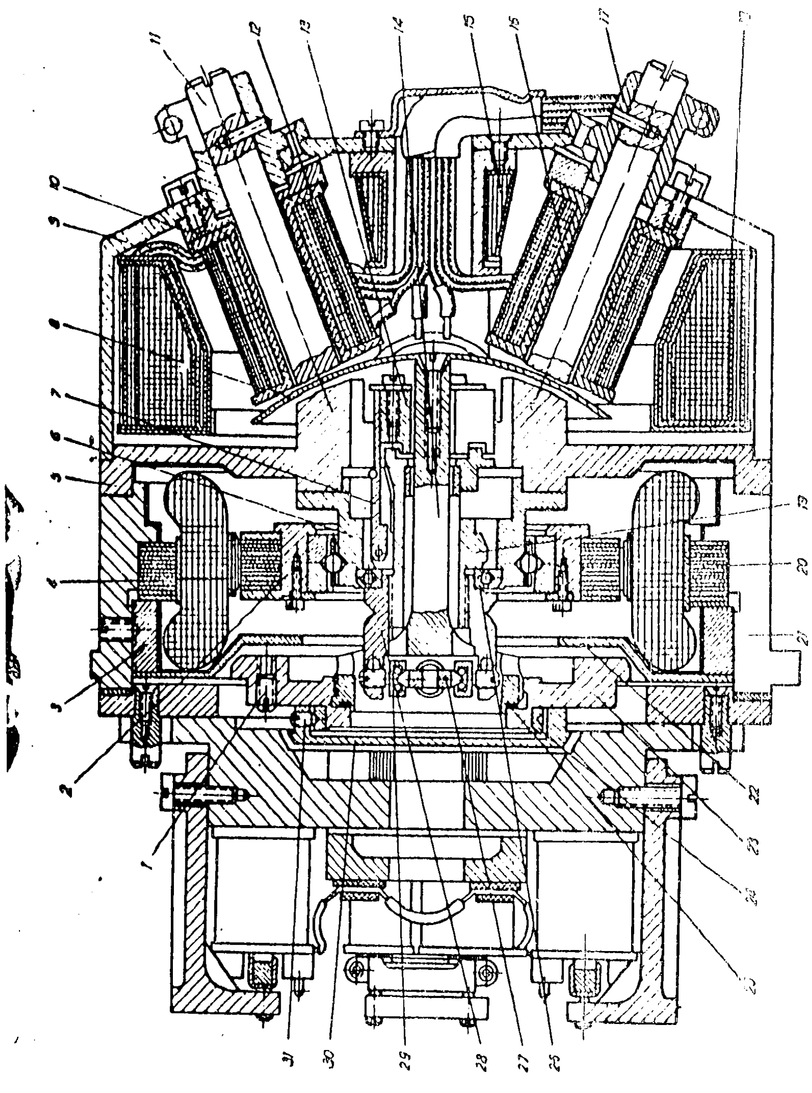


FIG. 66. ZERO GYRO CONSTRUCTION

1 - balance screw; 2 - bushing; 3 - ring; 4 - rotor; 5 - cover; 6 - bushing; 7 - rod; 8 - aluminium dome, 9 - housing; 10 - flange; 11 - [illegible]; 12 - roller, 13 - weight; 14 - axle; 15 - correction coil; 17 - bushings; 18 - former; 19 - bushing; 20 - stator; 21 - base plate; 22 - screen; 23 - [illegible]; 24 - [illegible]; 25 - shim; 26 - bearing; 27 - gimbal; 28 - holder; 29 - bearing race; 30 - inductor transmitter armature; 31 - [illegible].

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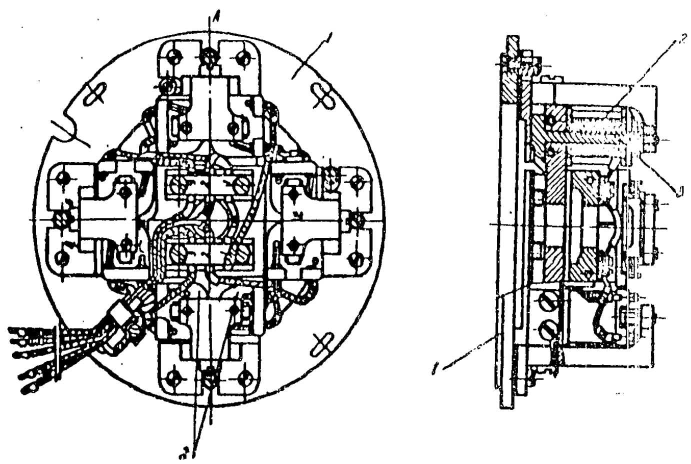

FIG.67. INDUCTIVE TRANSMITTER
1 - base plate; 2 - coils; 3 - core.

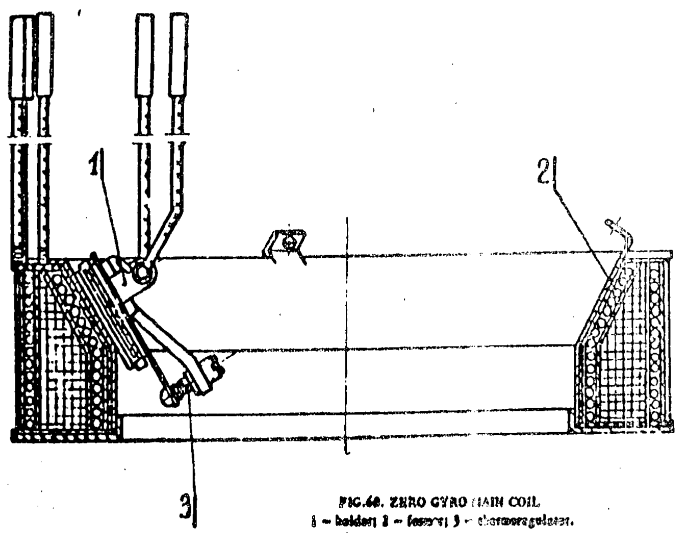

FIG.68. ZERO GYRO MAIN COIL
1 - holder; 2 - former; 3 - thermoregulator.

50X1-HUM

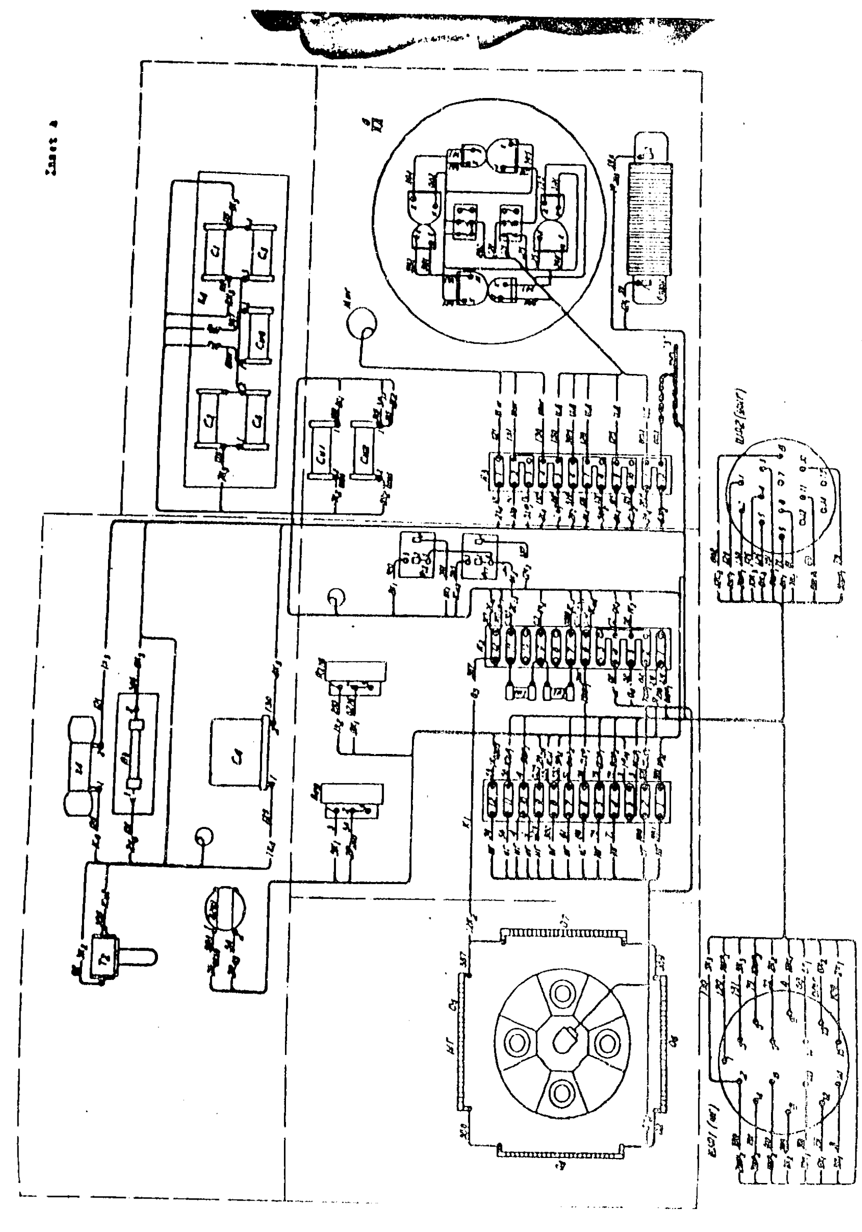

FIG.10. ZERO GYRO WIRING DIAGRAM

[redacted]

50X1-HUM

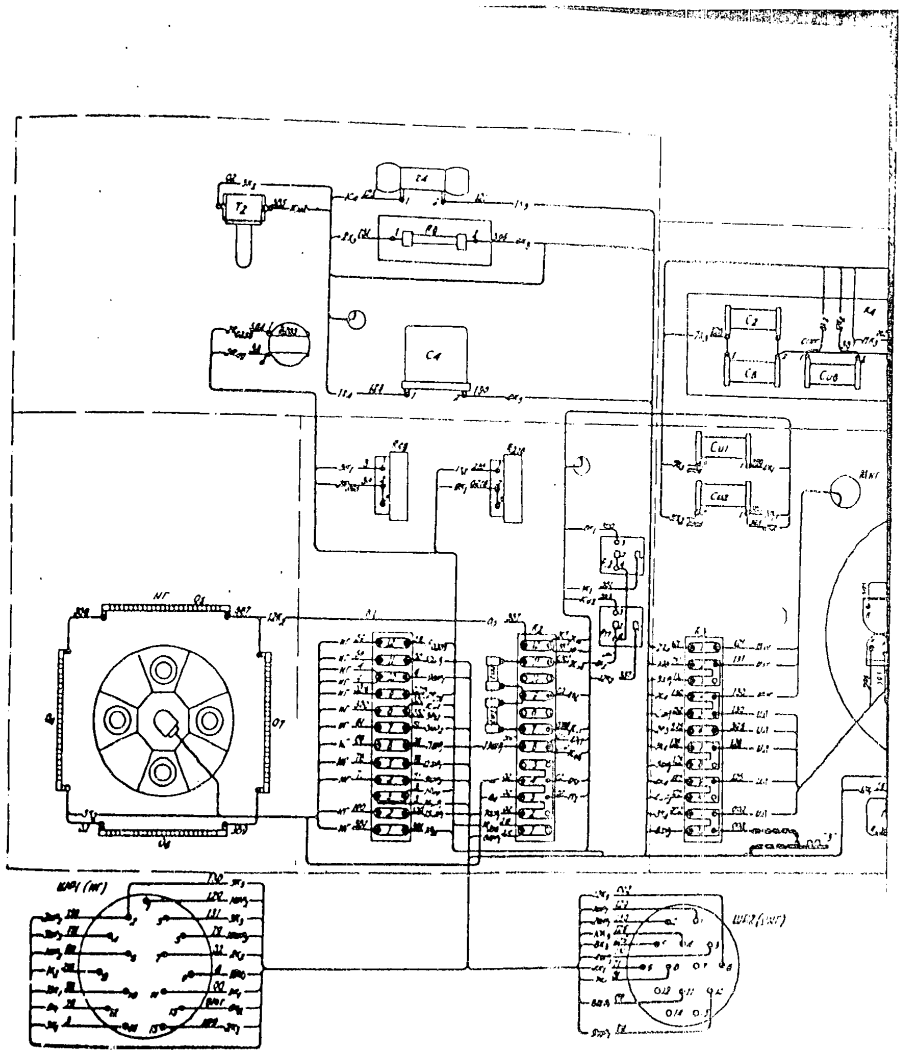

FIG.69. ZERO GYRO WIRING DIAGRAM

монтн. эл. сх. нульгироскопа ;

50X1-HUM

Inset 5

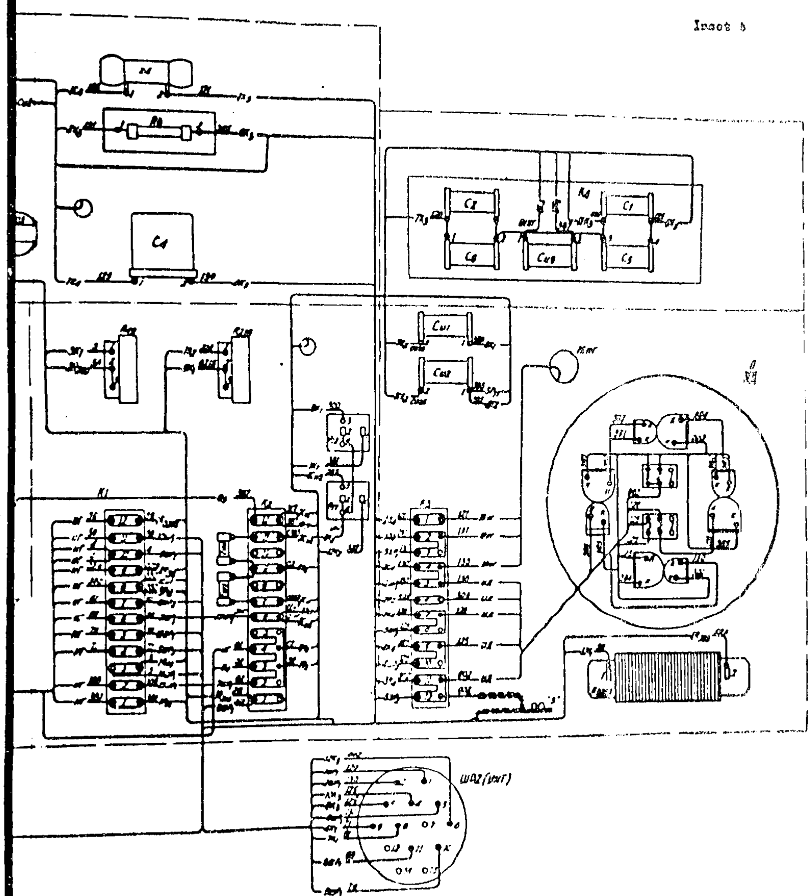

FIG.49. ZERO GYRO WIRING DIAGRAM

монт. эл. сх. нульгироскопа;

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[redacted]

50X1-HUM

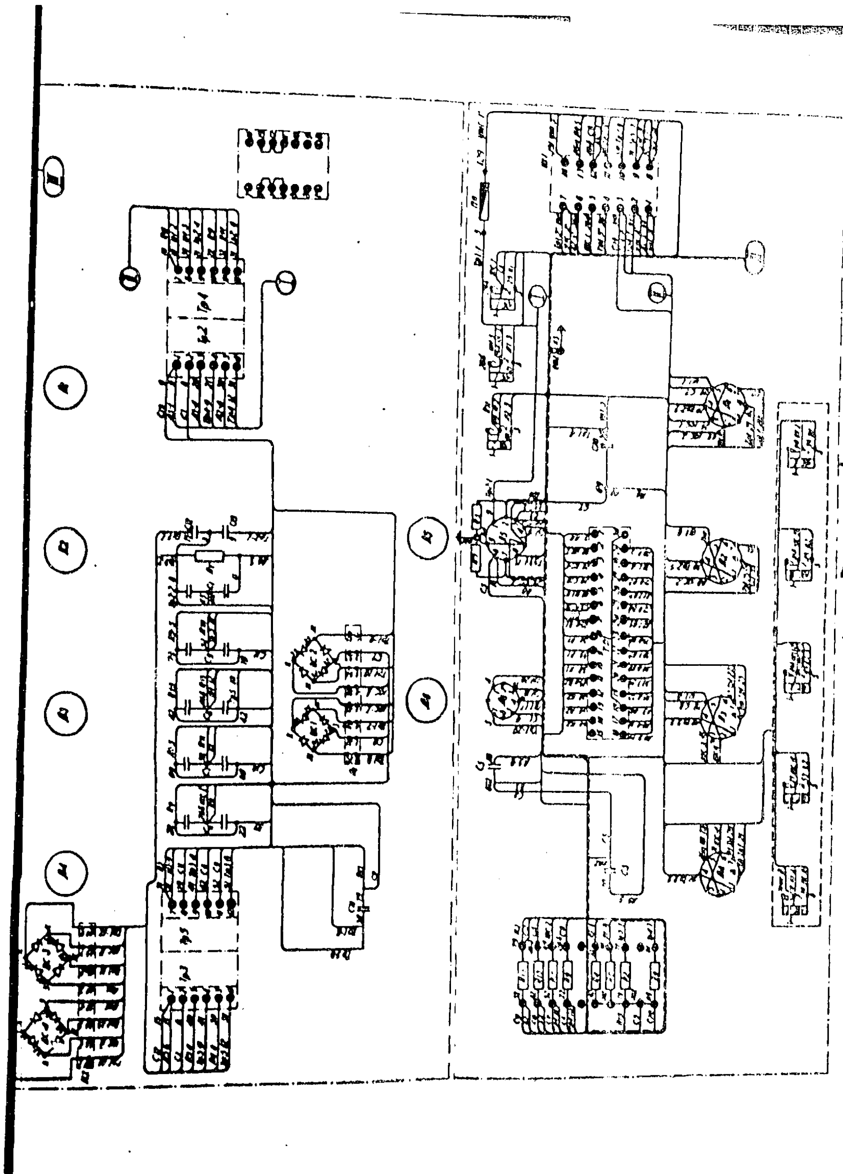
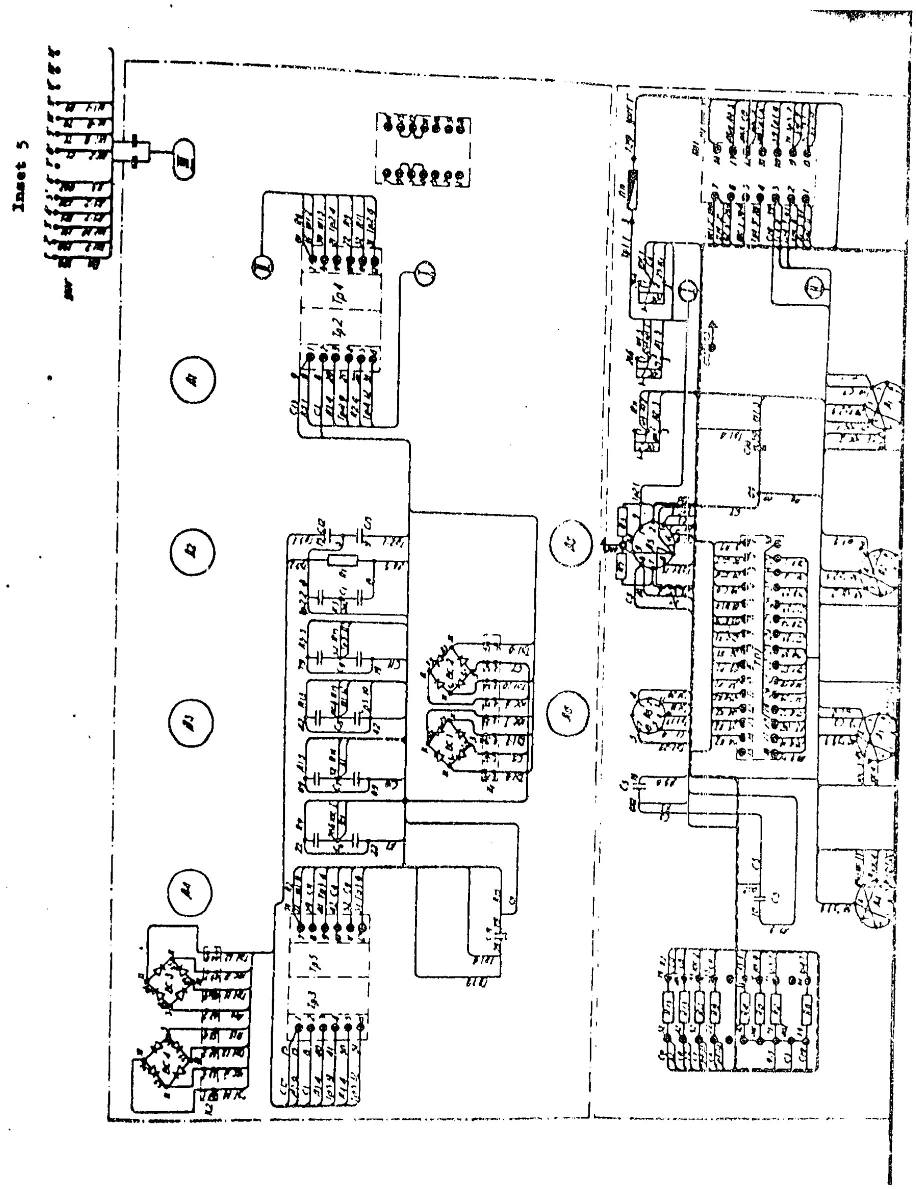
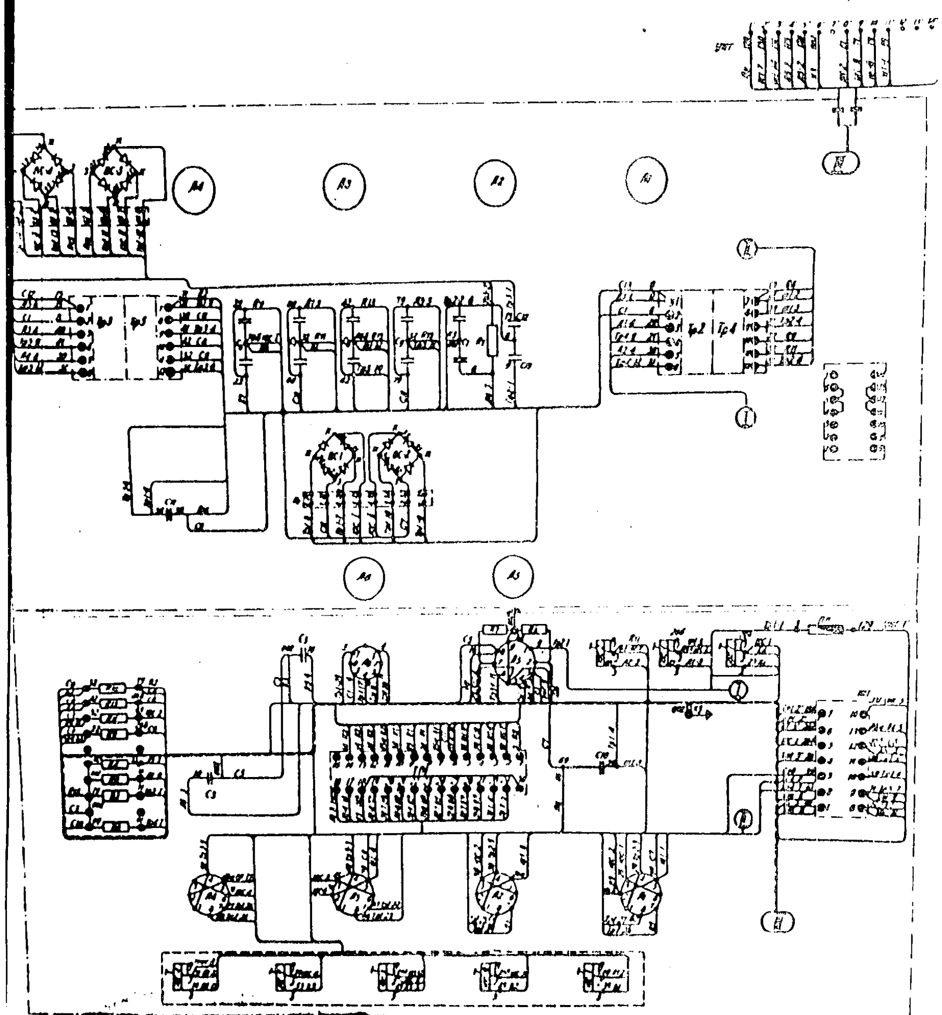


FIG.72. ZERO GYRO AMPLIFIER WIRING DIAGRAM


Inset 5

50X1-HUM

Annex 5



монтаж. Д.А. ... нуль-органа.

... 12. ZERO GYRO AMPLIFIER WIRING DIAGRAM

50X1-HUM

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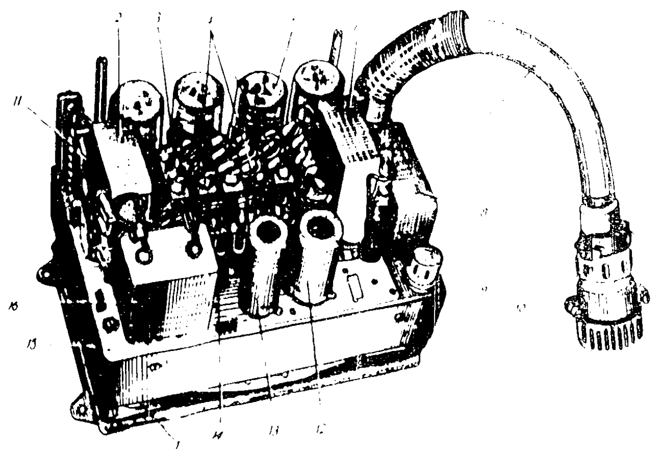

FIG. 70. ZERO GYRO AMPLIFIER (WITHOUT JACKET)

1 – spring loaded shock-absorber, 2 and 6 – interstage and feed back transformers of horizontal and vertical channels, 3 – filter capacitor of rectifier circuit, 4 – bias circuit capacitors, 5 – power amplifier stages valves, 7 – cable of zero amplifier, 8 – reference connector, 9 – fuze, 10 – connector, 11 – bias circuit selenium rectifiers for valves [illegible] and [illegible], 12 – voltage amplifier valve, 13 – kenotron, 14 – bias circuit selenium rectifiers for valves [illegible] and [illegible], 15 – horizontal plate, 16 – output filter capacitor

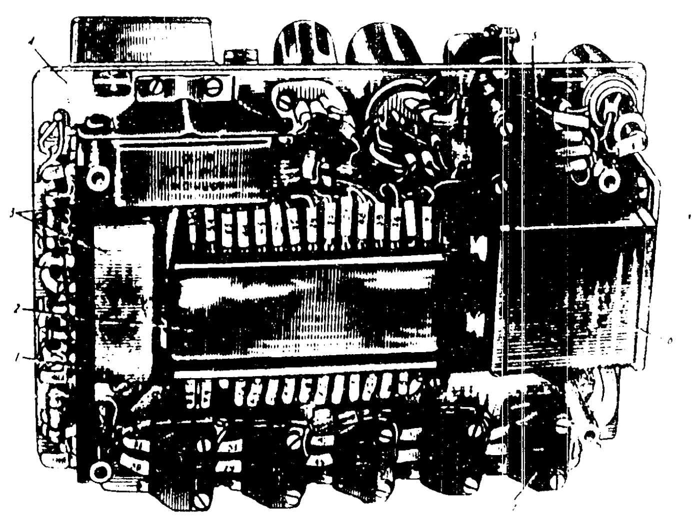

FIG. [illegible] ZERO GYRO AMPLIFIER (BOTTOM VIEW)

1 – panel with resistors, 2 – power transformer, 3 – automatic bias filter capacitor, 4 – horizontal [illegible], 5 and 7 – adjusting resistors, 6 – output filter capacitor

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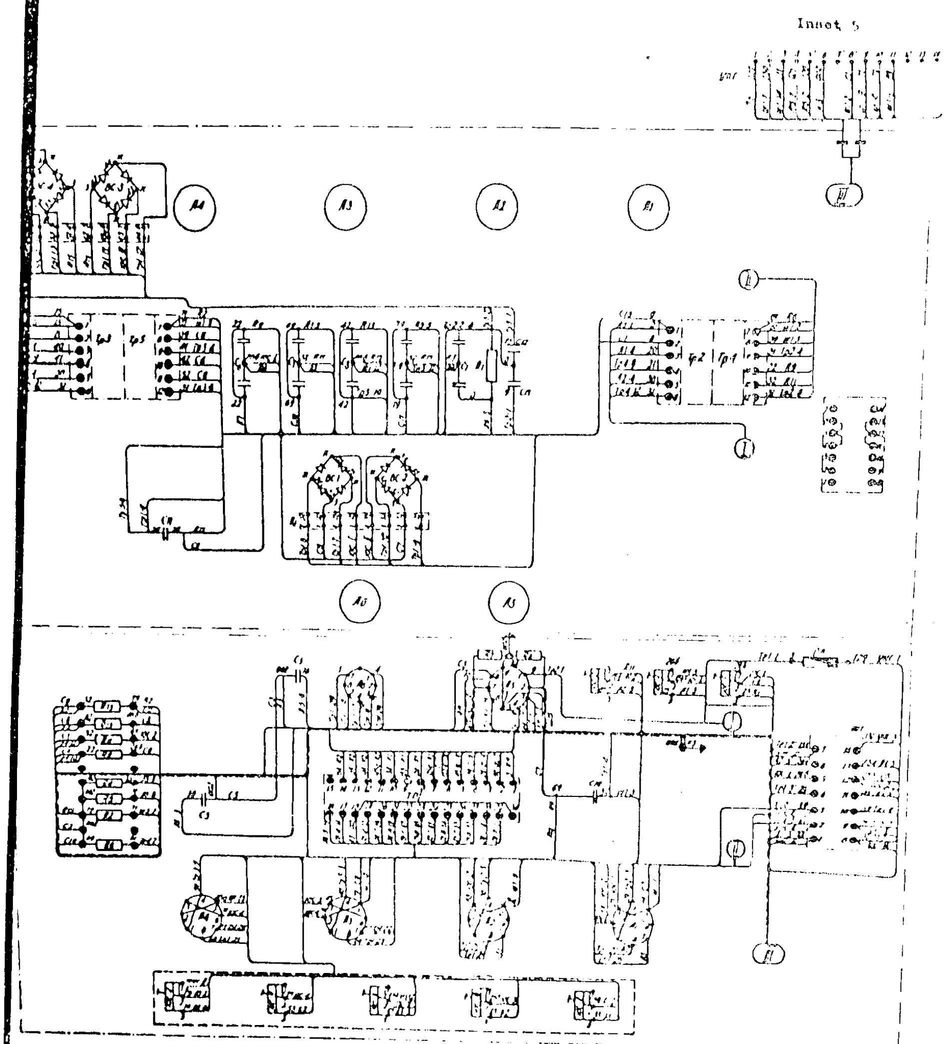

монтаж. эл. сх. усилителя нулевого прибора.

FIG. 11. ZERO GYRO AMPLIFIER WIRING DIAGRAM

50X1-HUM

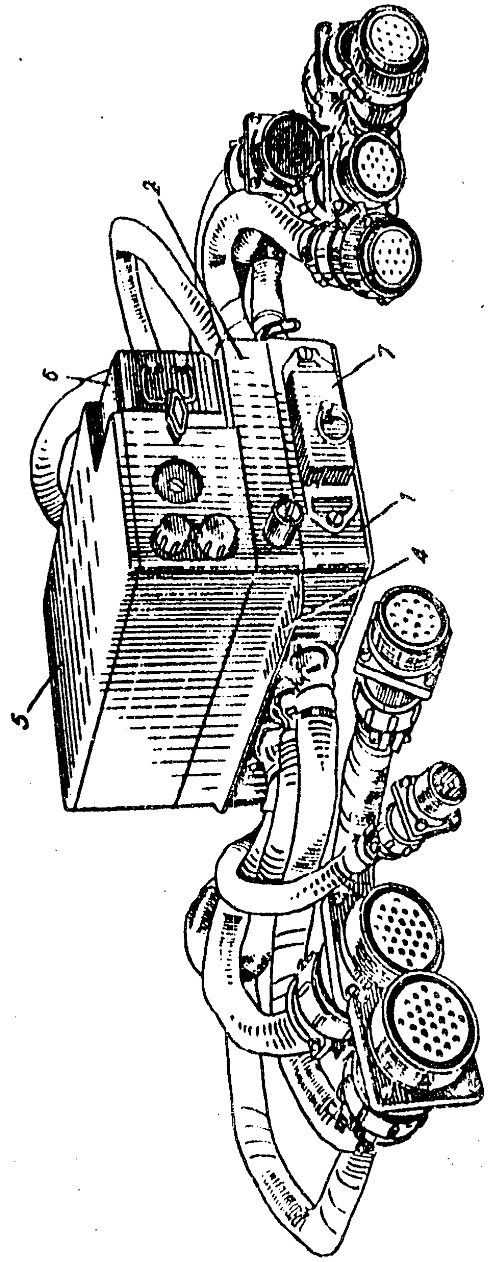

FIG.73. CONTROL BOX
1 – distribution box; 2 – control box; 4 – screw; 5 – jacket; 6 – removable unit; 7 – blanking plug.

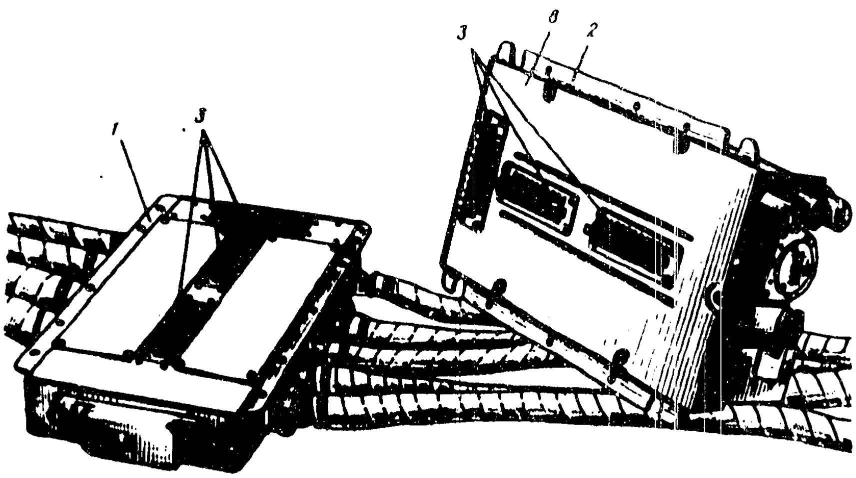

FIG.74. CONTROL BOX
1 – distribution box; 2 – control box; 3 – connectors; 8 – cover.

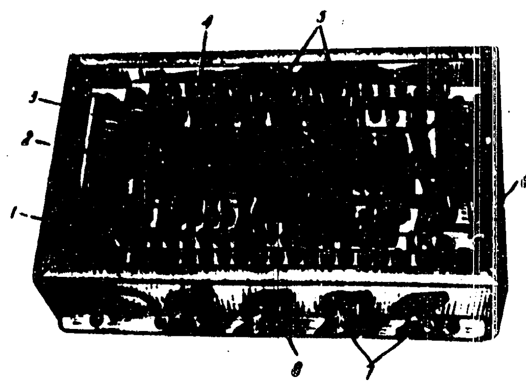

FIG.75. DISTRIBUTION BOX (BOTTOM VIEW)
1,6 – brackets; 2 – reference connector; 3 – housing; 4 – distribution block; 5 – connectors; 7 – clamp; 8 – cable.

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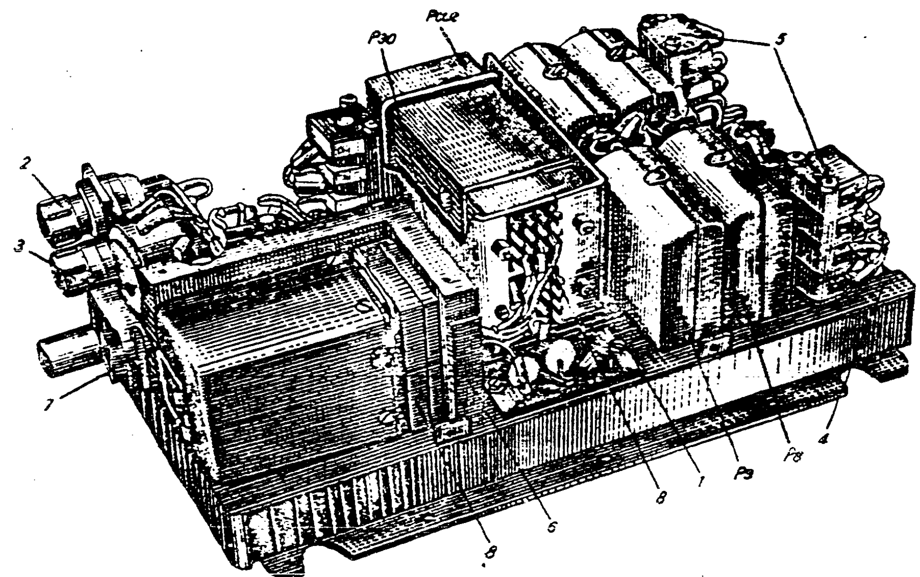
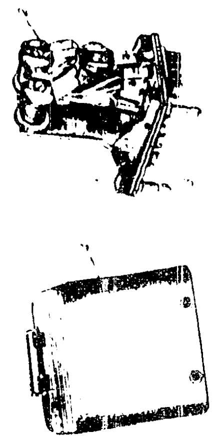


FIG.76. RELAY BOX

1,6 – brackets; 2,3 – fuses; 4 – plate; 5 – adjusting resistors; P_2, P_3 – ballistics relay; P_8 – radar ranging unit or manual range control actuating relay; P_9 – lock relay; P_{30} – electromagnetic limiter relay; 7 – latch; 8 – terminal block; P_{CLT} – break-off signalling relay.



[illegible] REMOVABLE UNIT
[illegible]

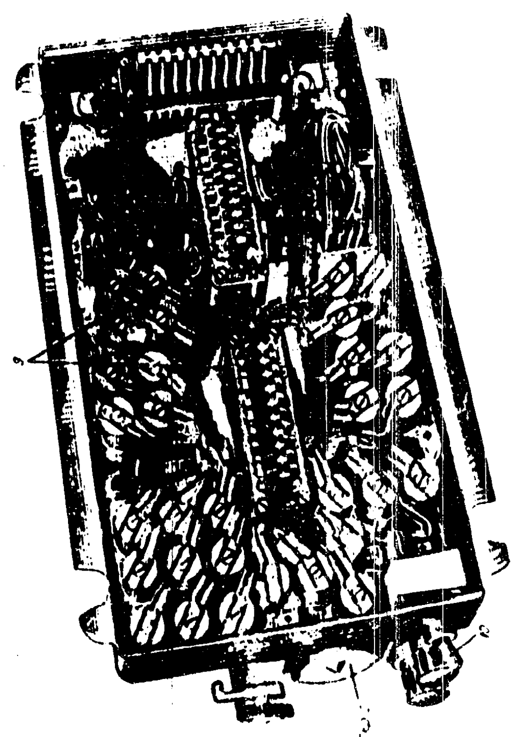
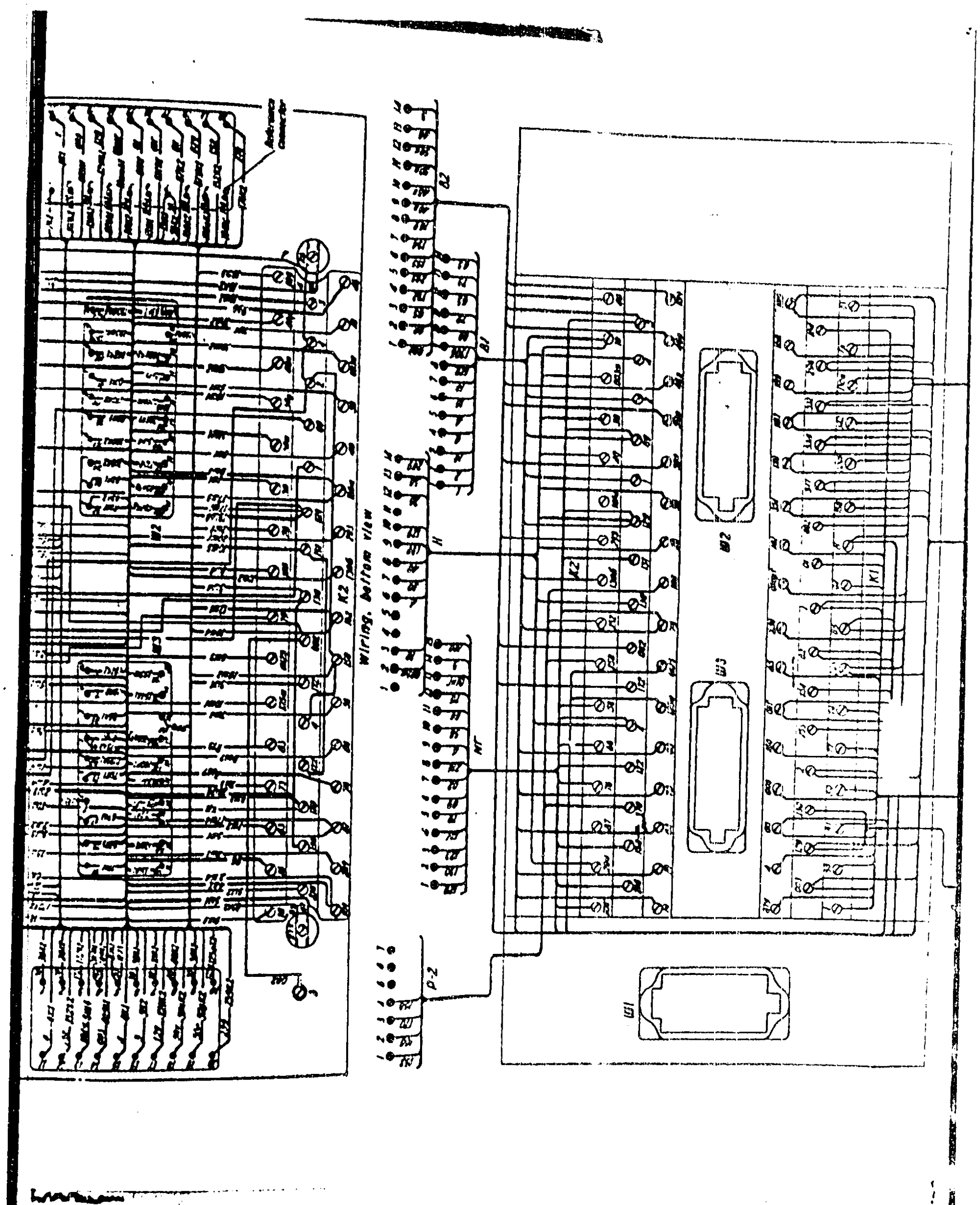


FIG. [illegible] RELAY BOX BOTTOM VIEW
[illegible]

50X1-HUM



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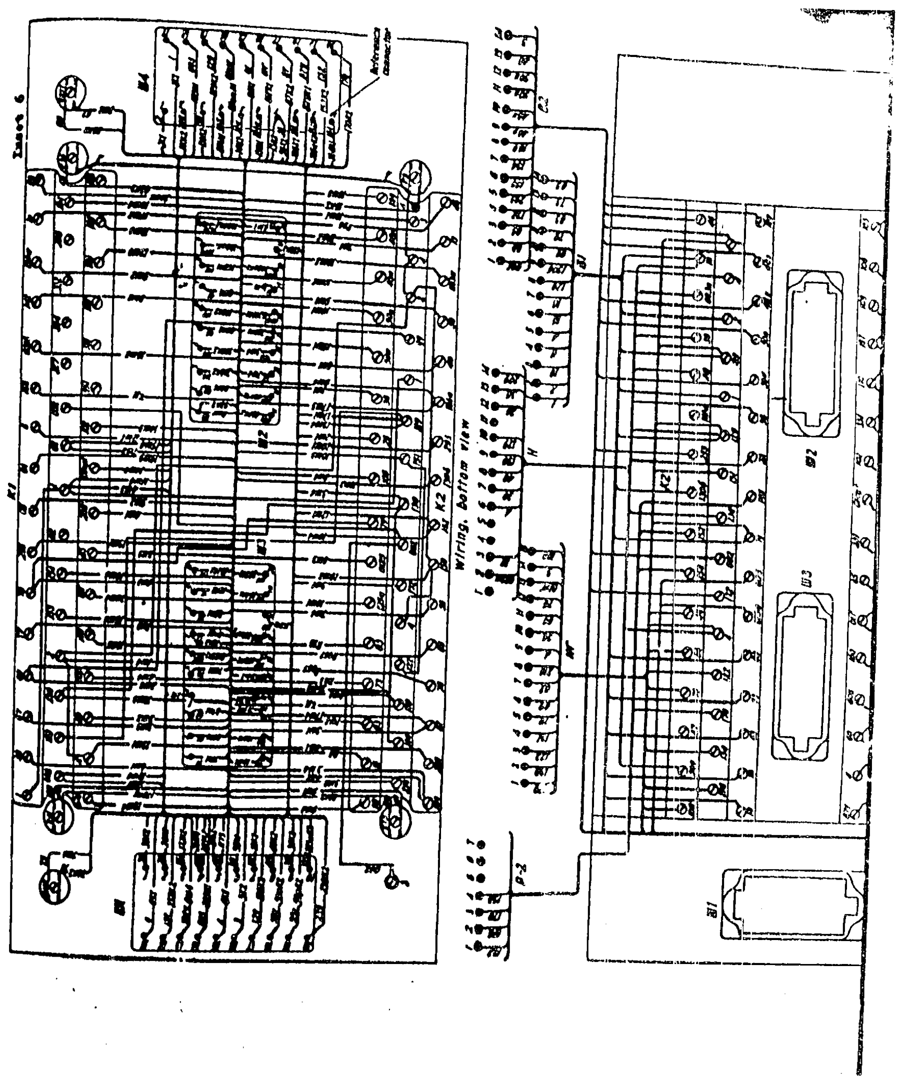
Wiring, bottom view

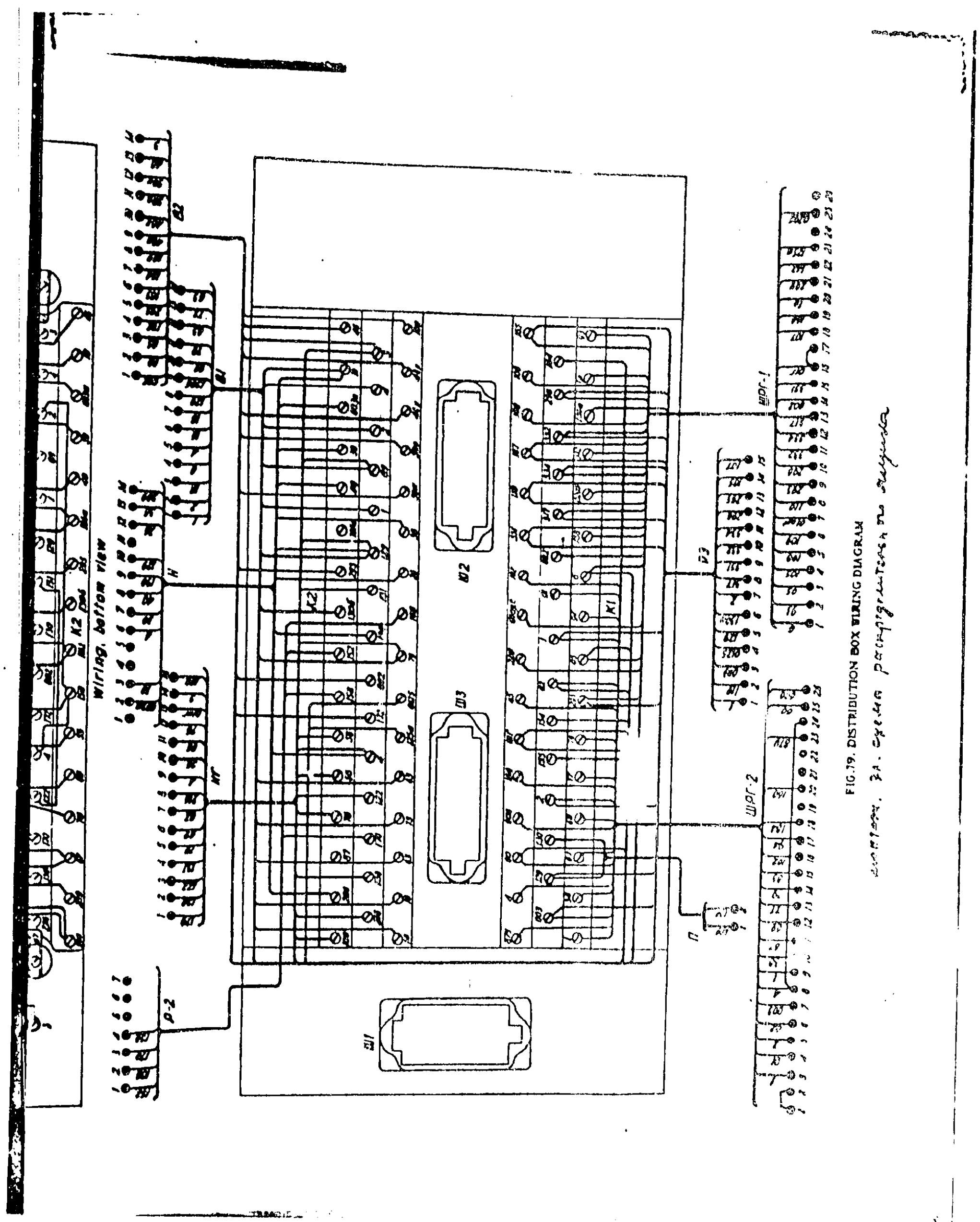

FIG. 19. DISTRIBUTION BOX WIRING DIAGRAM

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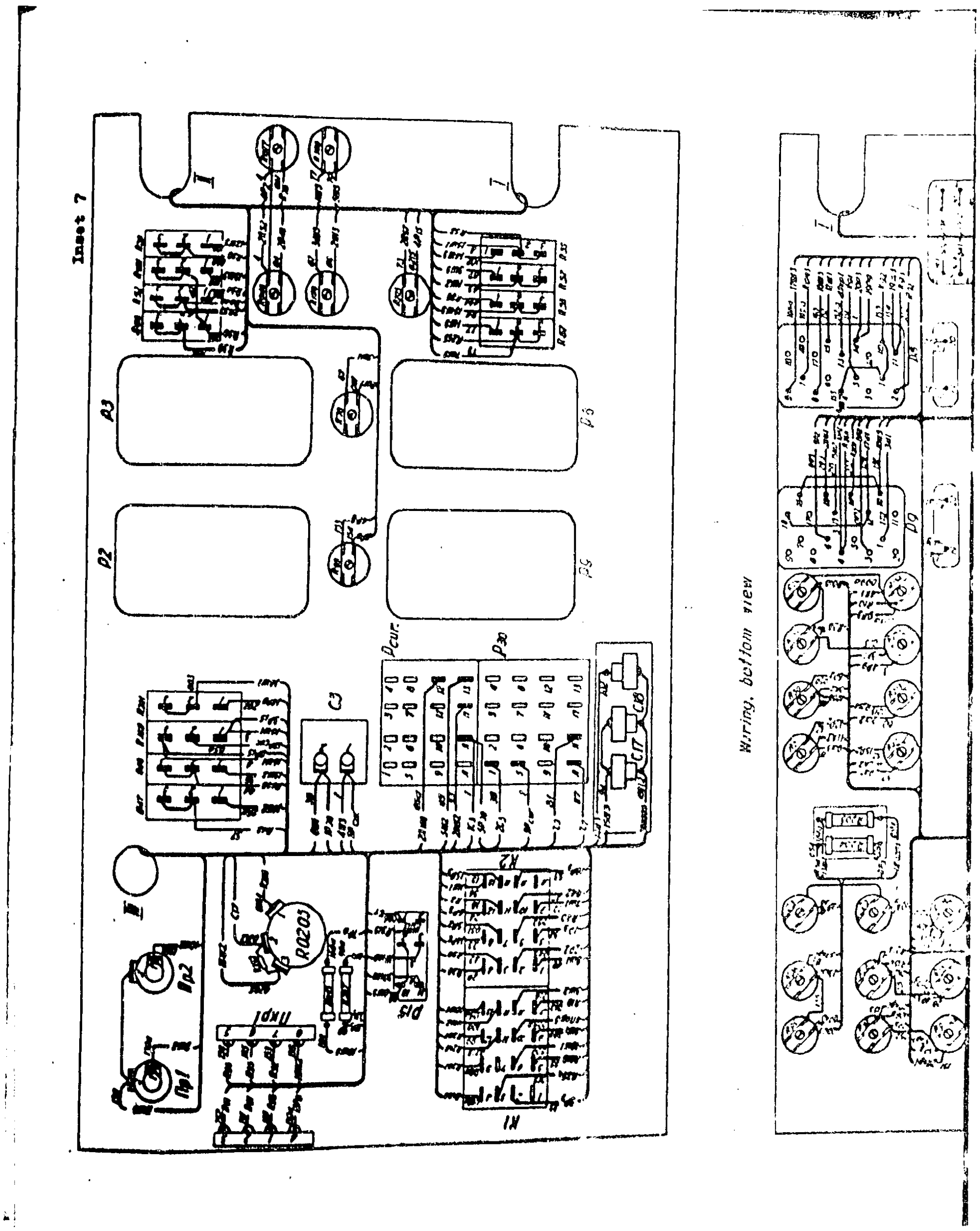
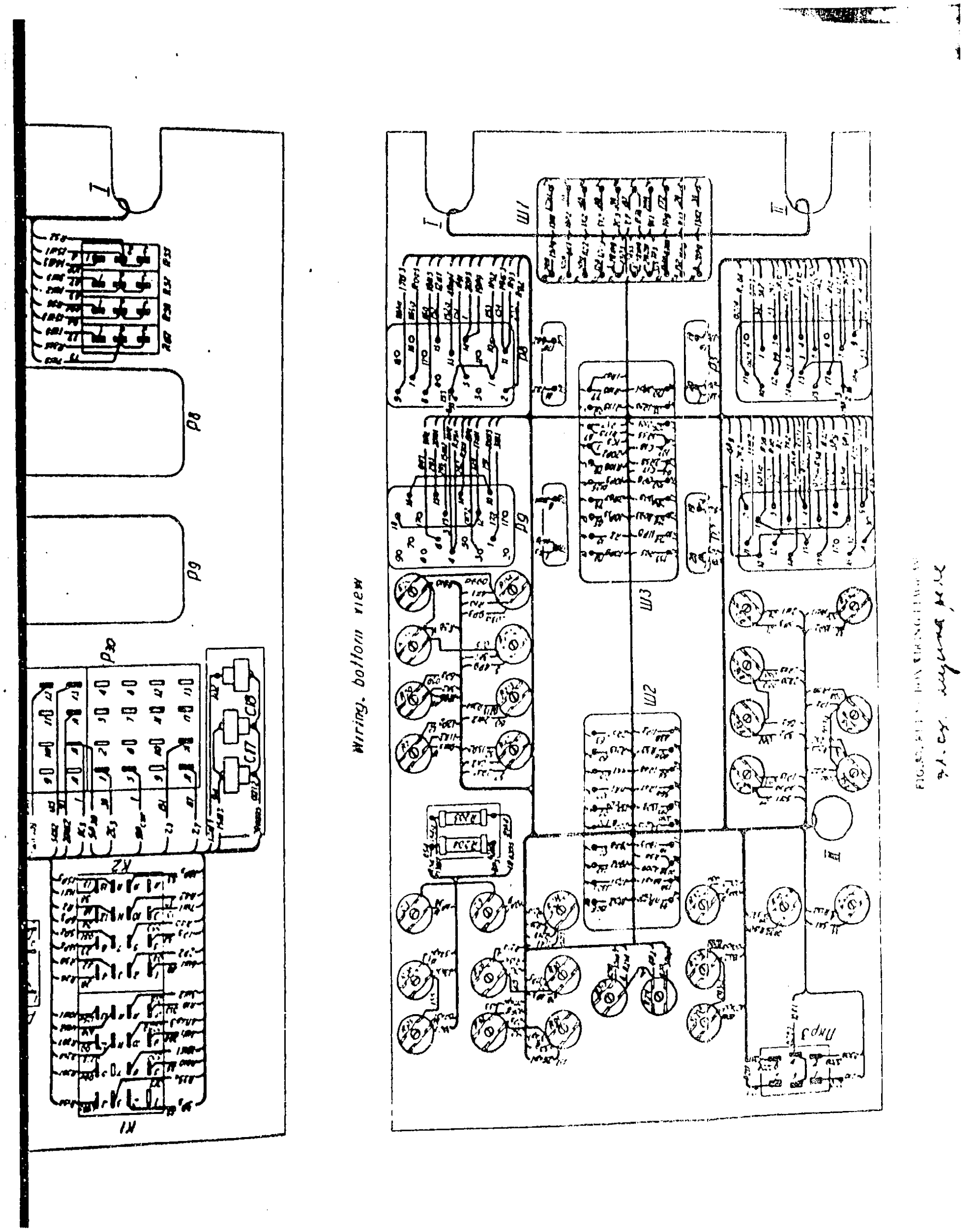

Inset 7
Wiring, bottom view

50X1-HUM



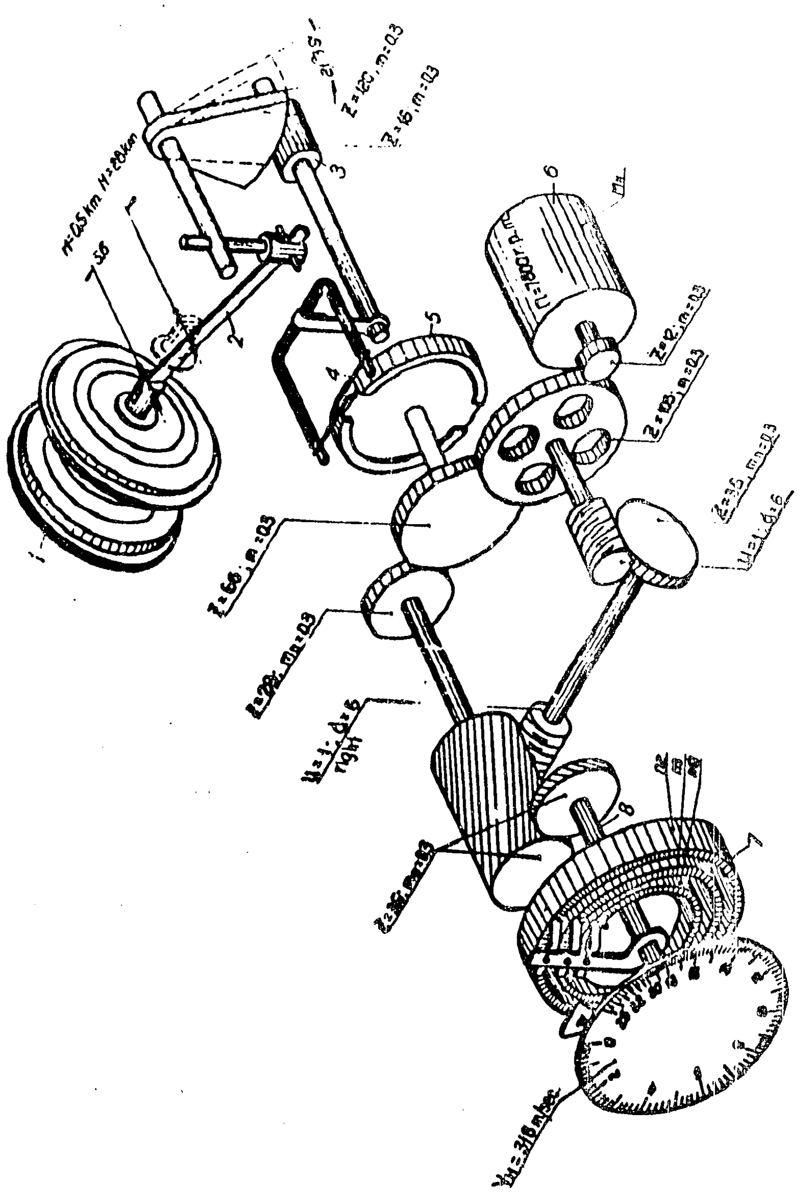


FIG. 81. ALTITUDE UNIT GEAR TRAIN

1 — aneroid capsules; 2 — crank mechanism; 3 — pinion; 4 — contacts; 5 — disk; 6 — electric motor; 7 — poten[illegible]ters; 8 — output shaft.

50X1-HUM

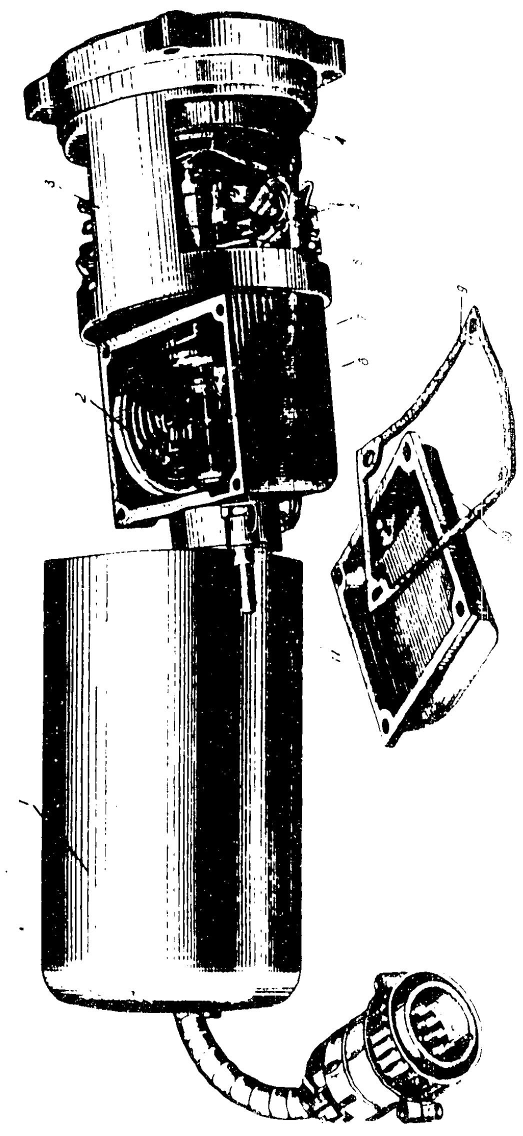


FIG 82. ALTITUDE UNIT (WITHOUT COVER).
1 — jacket; 2 — aneroid capsules; 3 — housing unit; 4 — potentiometer unit; 5 — adjusting resistors; 6 — capacitor; 7 — housing; 8 — air-tight chamber unit; 9 — gasket; 10 — cover; 11 — pipe connection.

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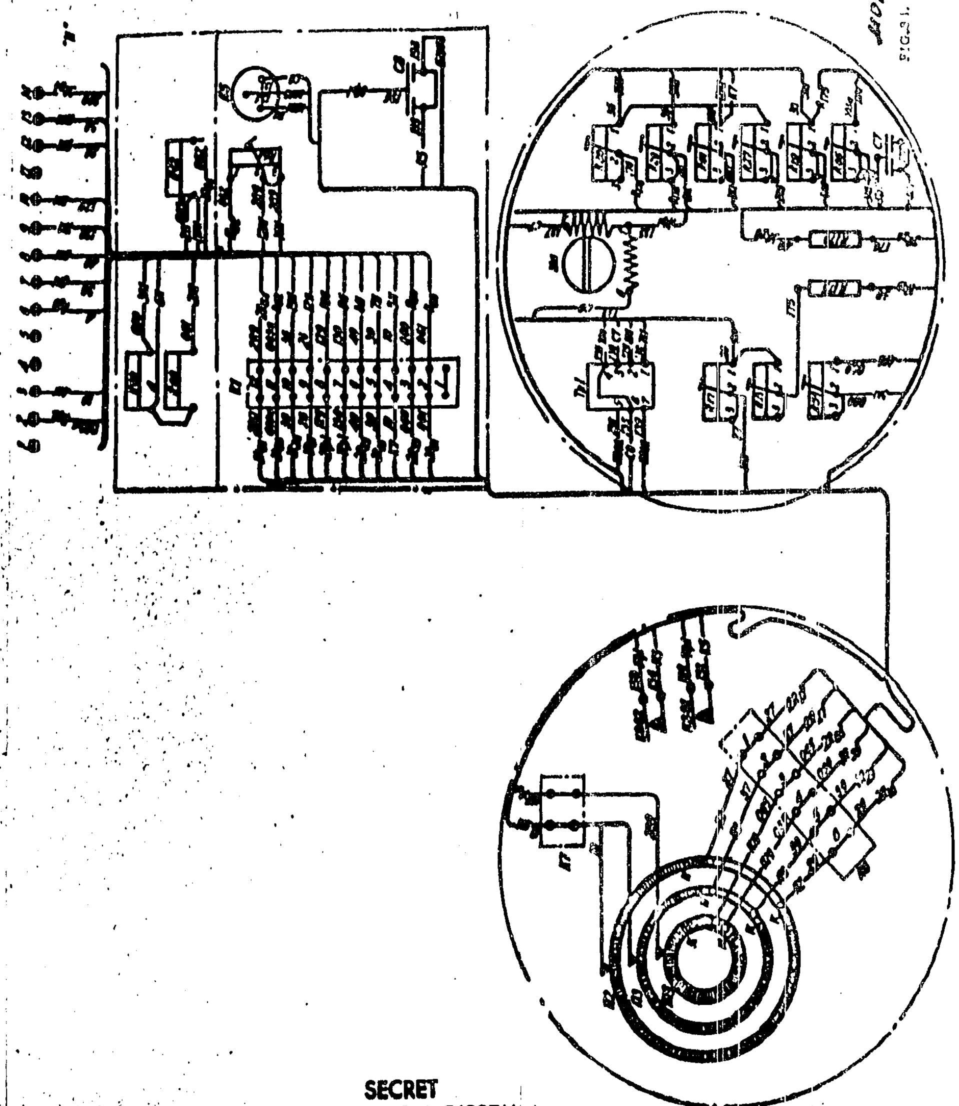

FIG. 31. ALTITUDE UNIT WIRING DIAGRAM

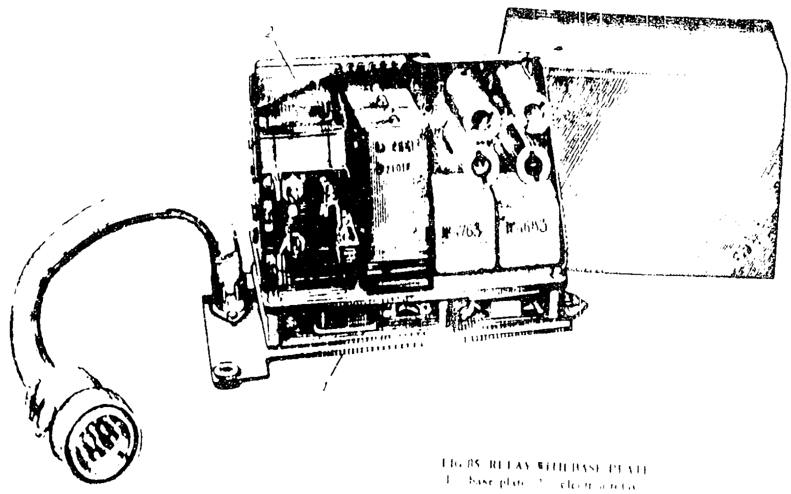

FIG. 85. RELAY WITH BASE PLATE
1 – base plate; 2 – electron relay

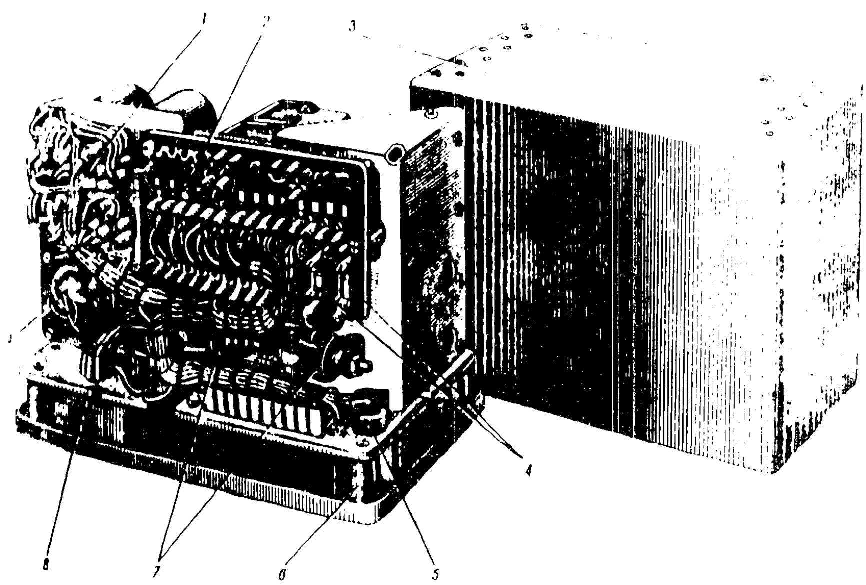

FIG. 86. ELECTRON RELAY
1 – valve panel; 2 – block with resistors; 3 – jacket; 4 – fuses; 5 – resistor R_{10}; 6 – strut; 7 – selenium rectifiers; 8 – base plate; 9 – panel

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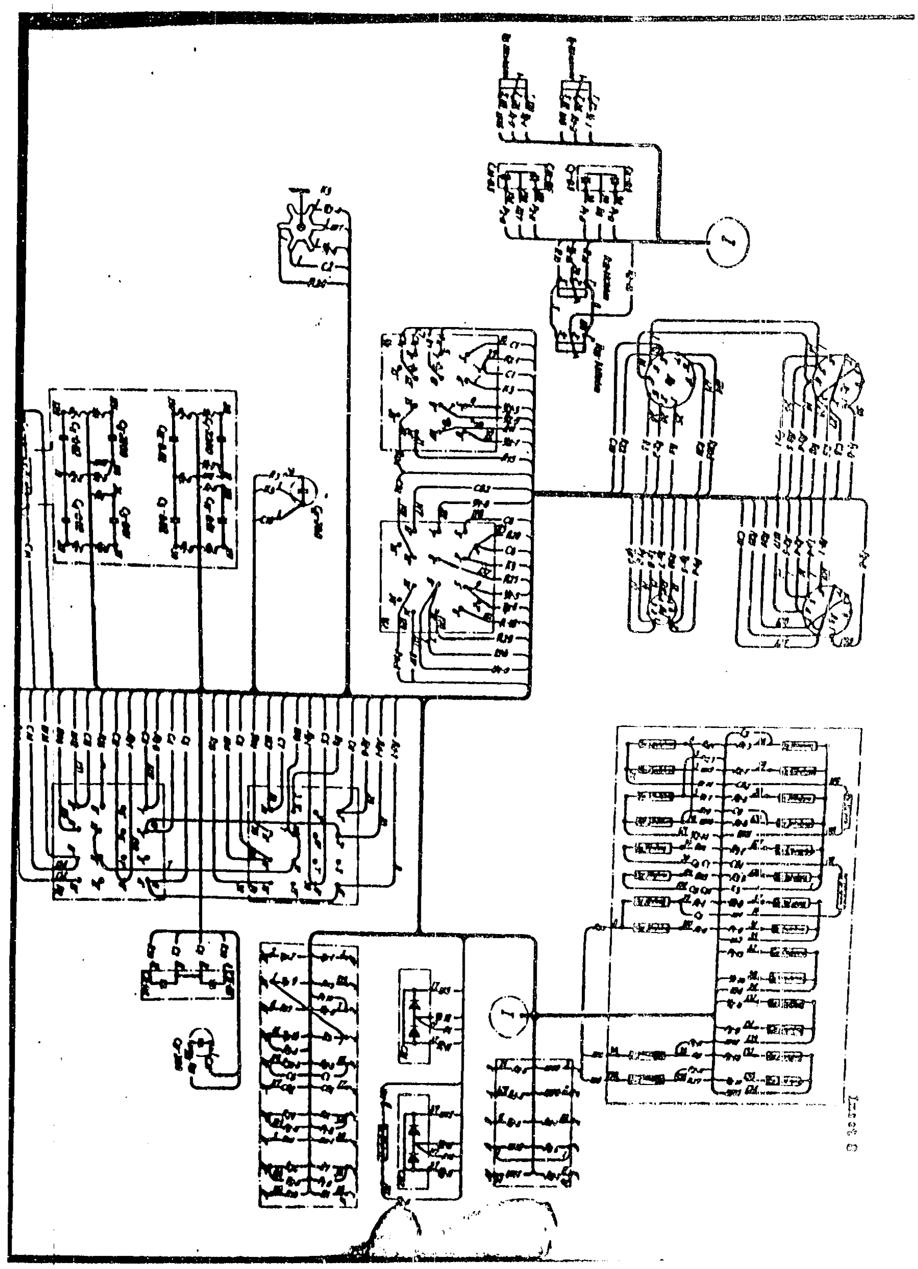

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50X1-HUM

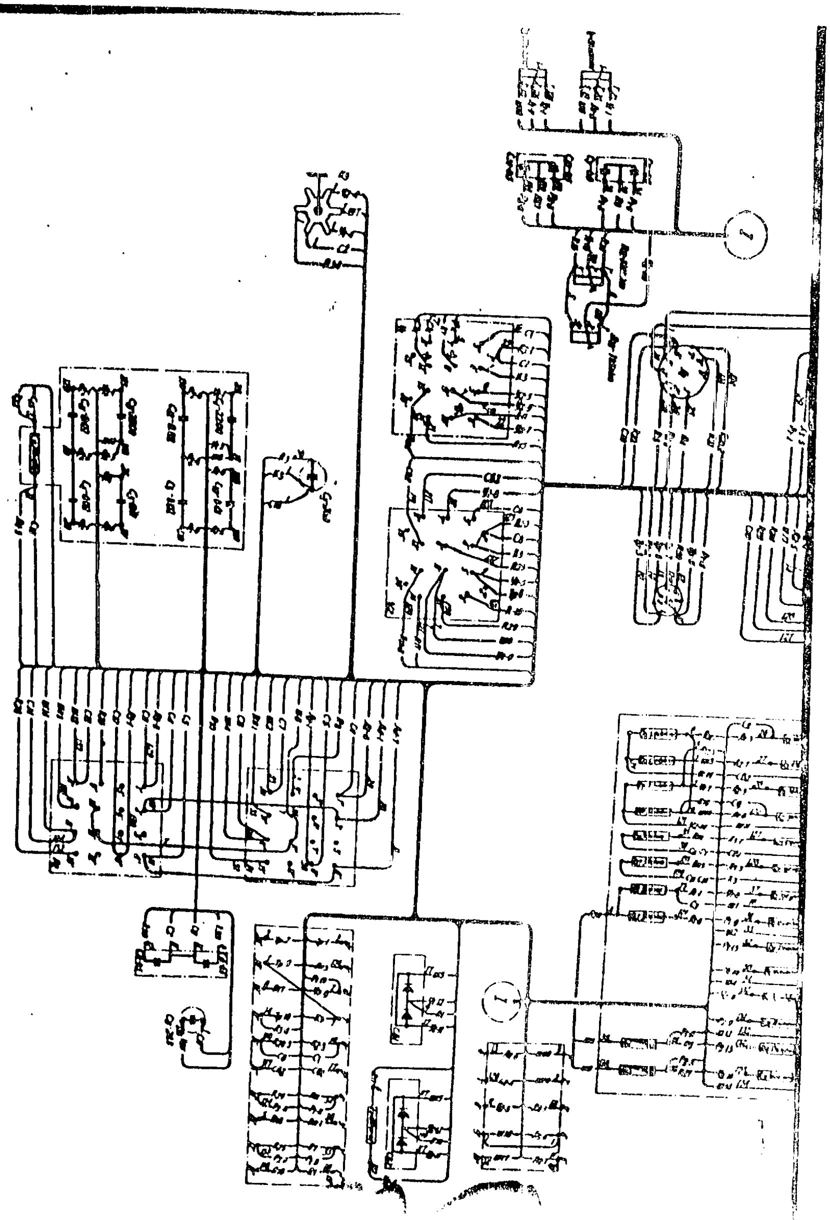

FIG. 81. ELECTRON RELAY TIMING DIAGRAM

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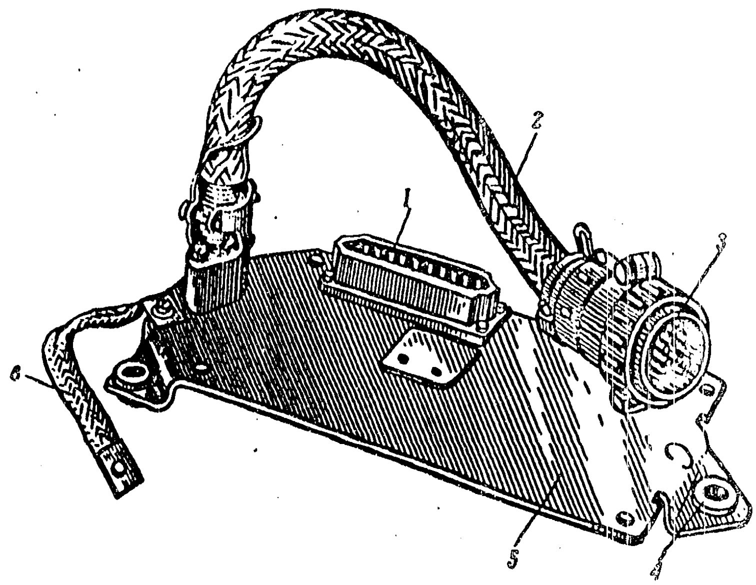

FIG.89. RELAY BASE PLATE
1 – connector; 2 – cable; 3 – connector; 4 – shock-absorber; 5 – base; 6 – bonding wire.

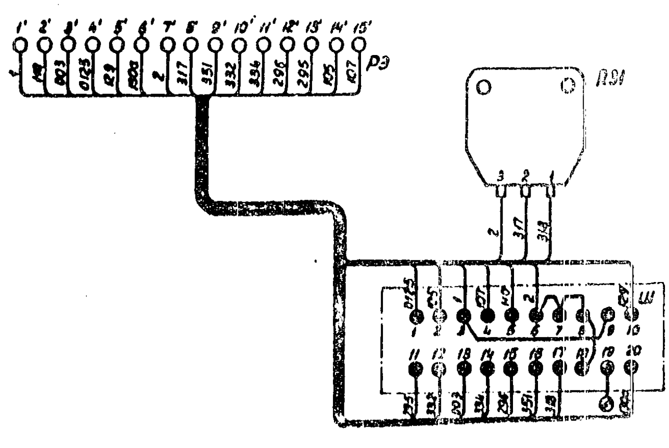

FIG.90. RELAY BASE PLATE WIRING DIAGRAM

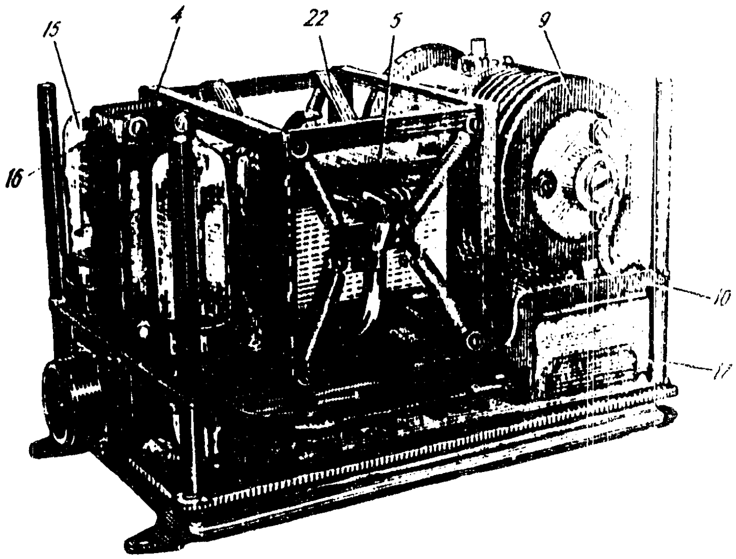

FIG.91. VOLTAGE REGULATOR WITH JACKET AND MAGNETIC SCREEN REMOVED
4 – shock absorbing frame; 5 – sensitive element; 9 – carbon regulator; 10 – plate; 15 – electron valve; 16 – bracket with resistors; 17 – struts; 22 – springs

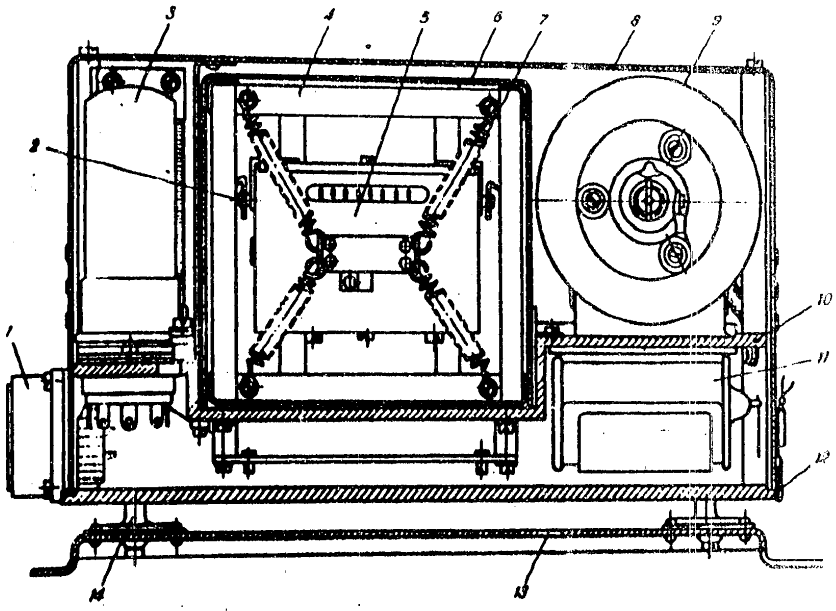

FIG.92. VOLTAGE REGULATOR (SIDE VIEW)

1 – connector; 2 – limiting springs; 3 – electron valve; 4 – shock absorbing frame; 5 – sensitive element; 6 – magnetic screen; 7 – spring; 8 – jacket; 9 – carbon regulator; 10 – common plate; 11 – capacitor; 12 – common plate; 13 – base plate; 14 – shock-absorbers.

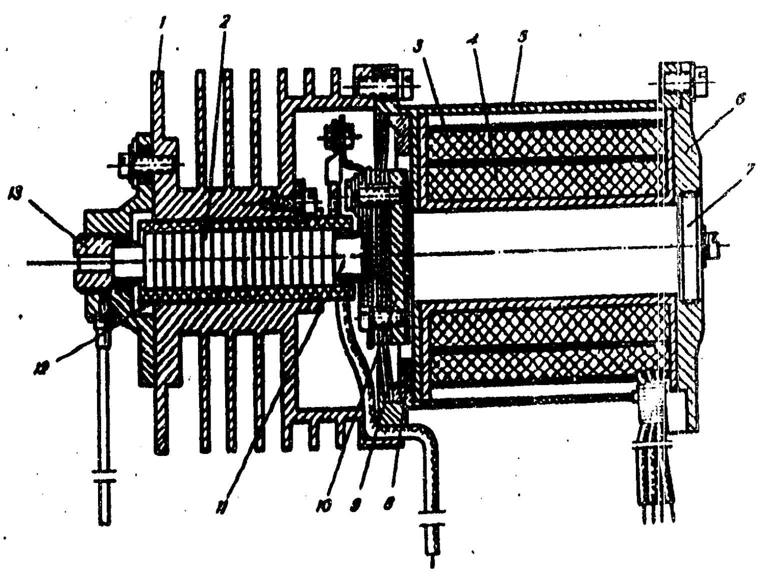

FIG.93. CARBON REGULATOR

1 – radiator body; 2 – carbon pile; 3 – additional winding; 4 – main winding; 5 – housing; 6 – cover; 7 – core; 8 – washer; 9 – blade springs; 10 – electromagnet armature; 11 – carbon contact; 12 – porcelain tube; 13 – adjusting screw.

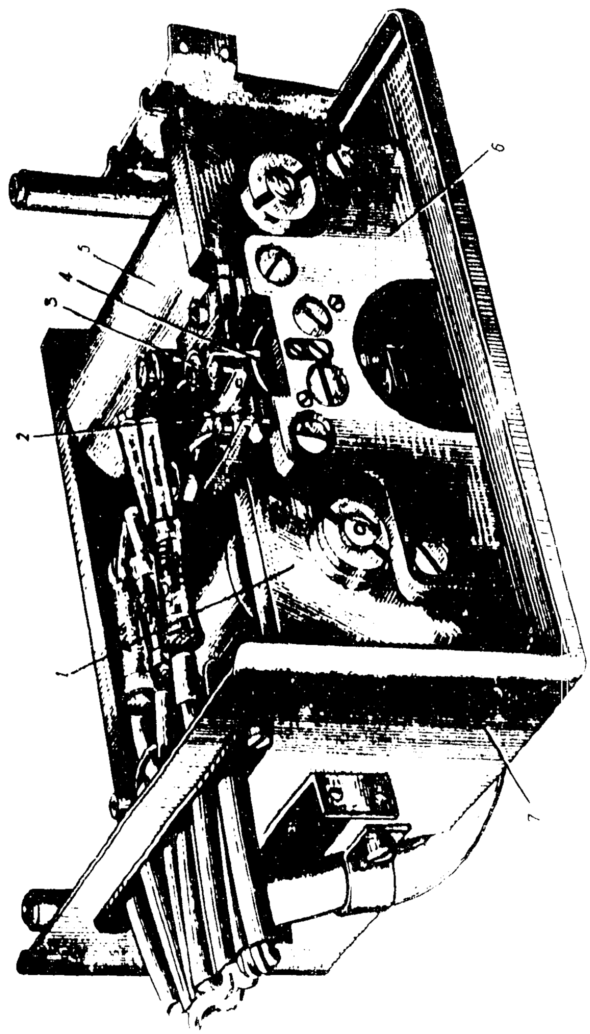

FIG. 91. SENSITIVE ELEMENT

1 – pole shoes, 2 – contacts, 3 – current-carrying springs, 4 – frame, 5 – permanent magnet, 6 – bracket, 7 – angle bar.

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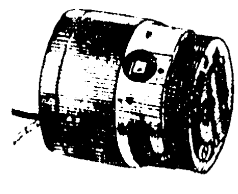

FIG. 95. ELECTRIC MOTOR ДГ-4М WITH JACKET AND BRUSH HOLDER COVER REMOVED (GENERAL VIEW)

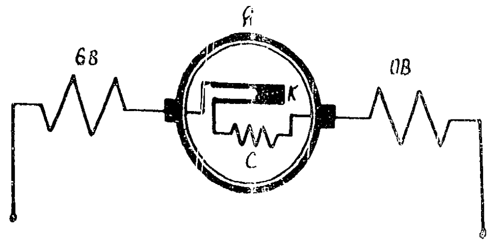

FIG. 96. CIRCUIT DIAGRAM OF ELECTRIC MOTOR ДГ-4М (ДГ-С)
ОВ – excitation winding; К – centrifugal regulator contacts; С – by-pass resistor; Я – armature.

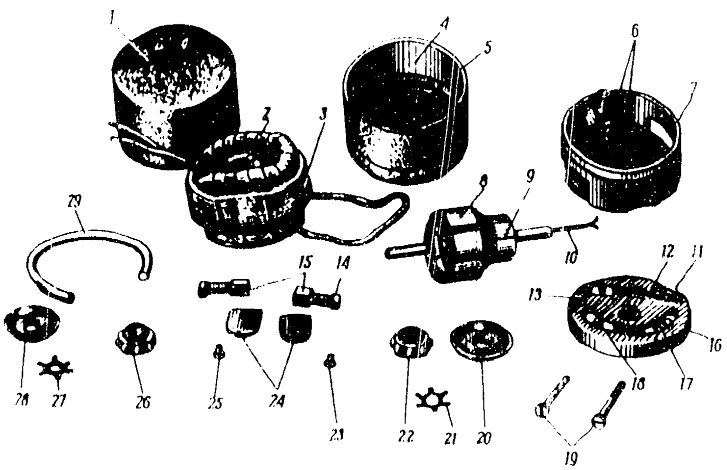

FIG. 97. ELECTRIC MOTOR ДГ-4М (DISASSEMBLED)
1 – jacket; 2 – excitation windings; 3 – stator; 4 – housing; 5 – rear shield; 6 – brush holder; 7 – front shield; 8 – armature; 9 – commutator; 10 – leads connecting centrifugal regulator contacts with electric motor armature; 11 – centrifugal regulator contacts; 12 – centrifugal regulator nut; 13 – centrifugal regulator; 14 – spring; 15 – brushes; 16 – by-pass resistor; 17, 18 – balance weights for electric motor rotor; 19 – screws for clamping front and rear shields; 20 and 28 – dust-protecting washers; 21 and 27 – play reducing washers; 22 and 26 – ball bearings; 23 and 25 – screws to secure covers 24; 29 – spring-loaded ring.

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FIG.98. ELECTRIC MOTOR ДП-3,5M (GENERAL VIEW)

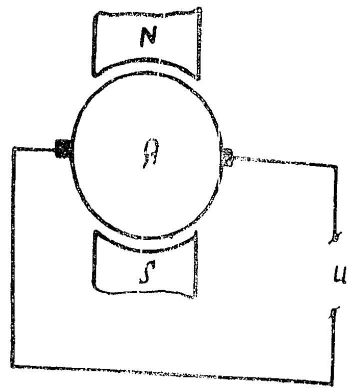

FIG.99. ELECTRIC MOTOR ДП-3,5M CIRCUIT

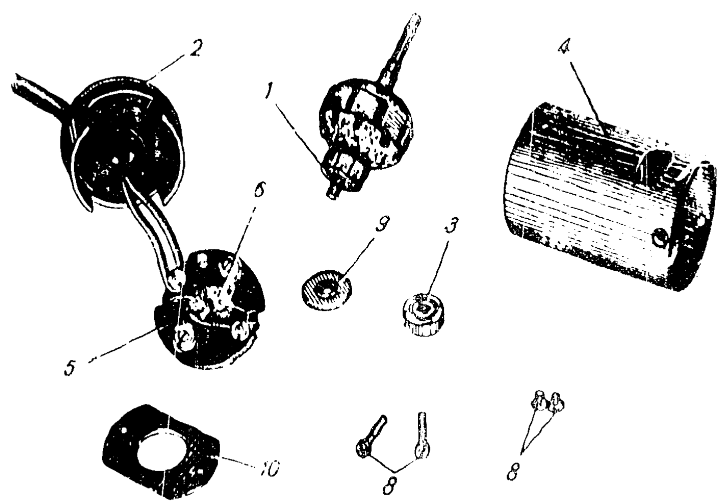

FIG.100. ELECTRIC MOTOR ДП-3,5M (DISASSEMBLED)
1 – armature; 2 – cover; 3 – ball bearing; 4 – housing; 5 – textolite plate with brushes; 6 – brushes; 7 – commutator; 8 – mounting screws; 9 – dust-protecting washer; 10 – insulation washer.

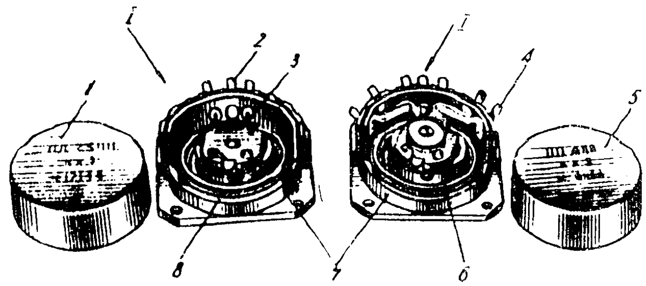

FIG.101. POTENTIOMETERS ПП AND ПЦ
1 – general view of potentiometers without cover; 1 and 5 – covers; 2 and 4 – leads-out to unsolder wires; 3 – brush; 6 and 8 – windings; 7 – housing.

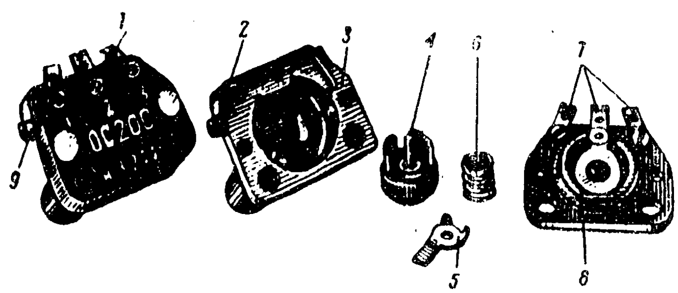

FIG.102. ADJUSTING RESISTORS
1 – general view; 2 – adjusting screw; 3 – housing; 4 – brush drive; 5 – brush; 6 – spring; 7 – leads-out; 8 – winding; 9 – spring.

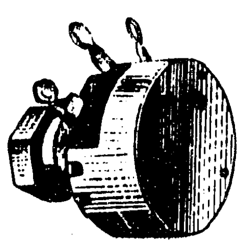

FIG.103. GENERAL VIEW OF ADJUSTING RESISTOR ПС-5000

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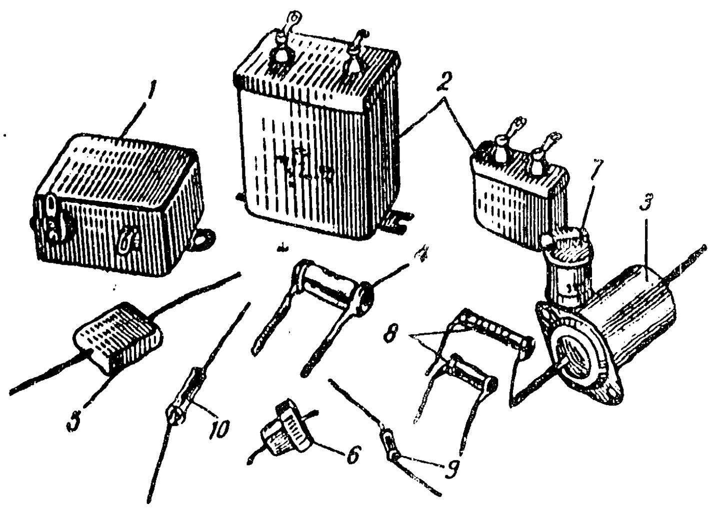

FIG.104. SIGHT ELECTRIC CIRCUIT ELEMENTS

1 – capacitor, type КЭГ, ОЖО.464.008 ТУ МРТП; 2 – capacitor, type МБГП, ГОСТ 7112-54; 3 – capacitor, type КВП,ОЖО.462.025 ТУ МРТП; 4 – capacitor, type КБГ-И, ГОСТ 6118-59; 5 – capacitor, type КСО,ГОСТ 6119-54; 6 – capacitor, type ЭТО,УБО 464014 ТУ МРТП; 7 – wire resistor manufactured in accordance with sight drawings; 8 – resistors, type ВС,ГОСТ 6562-53; 9 – resistor, type МЛТ, ГОСТ 7113-54; 10 – thermoresistor, type ММТ,УБО 468007 ТУ МРТП.

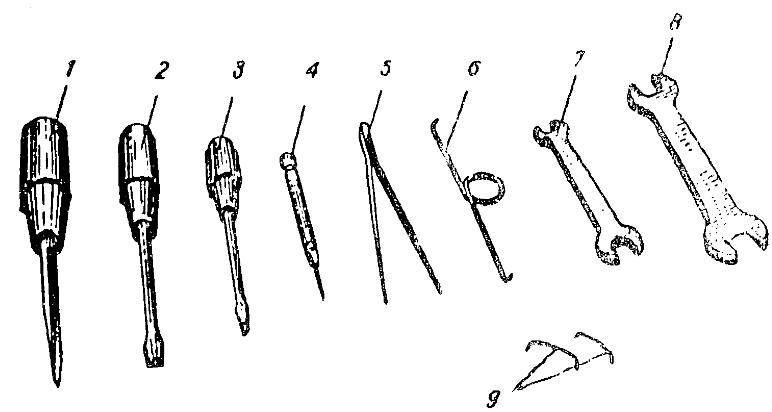

FIG.105. TOOLS OF SPT&A SET

1 – screw-driver, B175x0.7; 2 – zero gyro mounting screw-driver, B 150x0.4; 3 – warning lamps cover removing screw-drivers, B 100x0.3; 4 – watchmaker's screw-driver; 5 – pincers; 6 – gyro adjustment and bearings lubrication device; 7 – wrench, 9x11; 8 – wrench, 14x17 for zero gyro mounting; 9 – bracket to replace brushes.

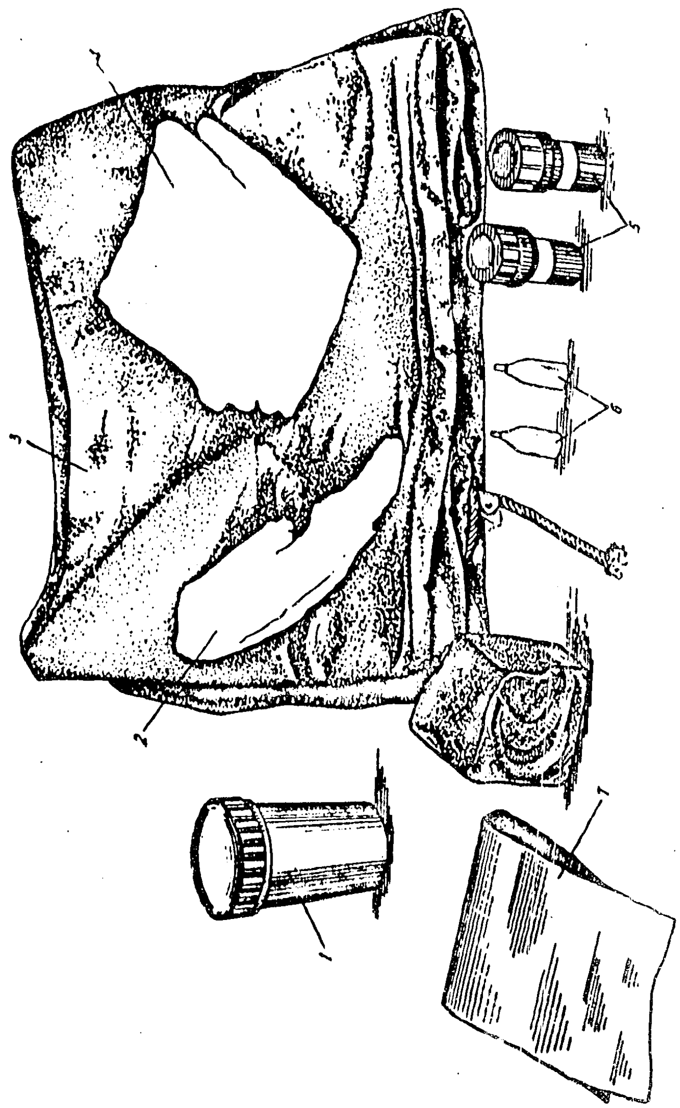

FIG.106. ACCESSORIES OF SPT&A SET

1 – can with oil; 2 – cambric tapes; 3 – cover; 4 – flannel; 5 – oilers with OKB - 122-5 oil; 6 – essential oil; 7 – sandpaper.

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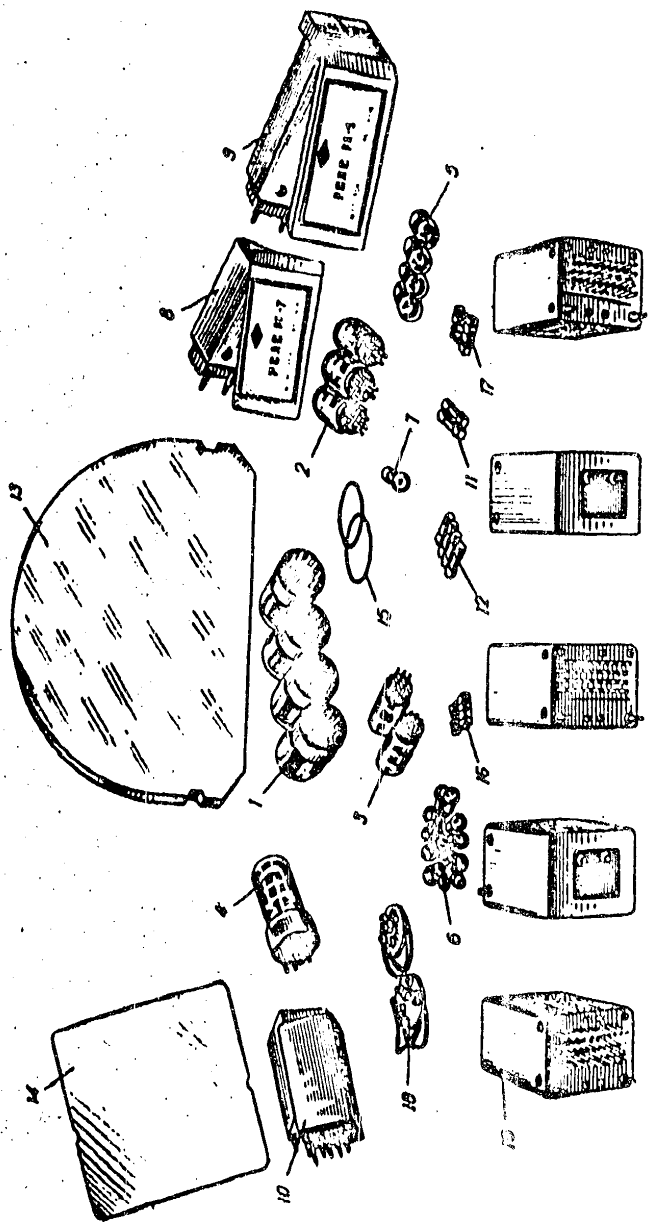

FIG. 107. SPARE PARTS OF SPTA SET

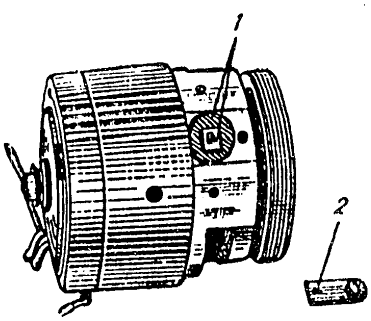

FIG.108. ELECTRIC MOTOR WITHOUT JACKET.
1 – brush holder; 2 – screw.

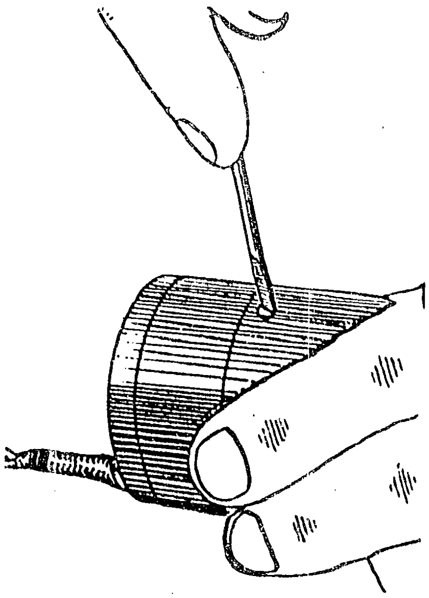

FIG.109.

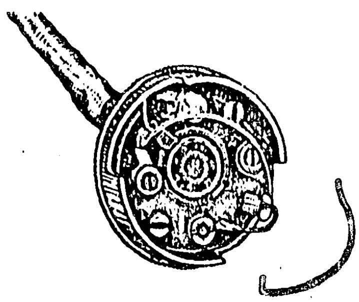

FIG.110

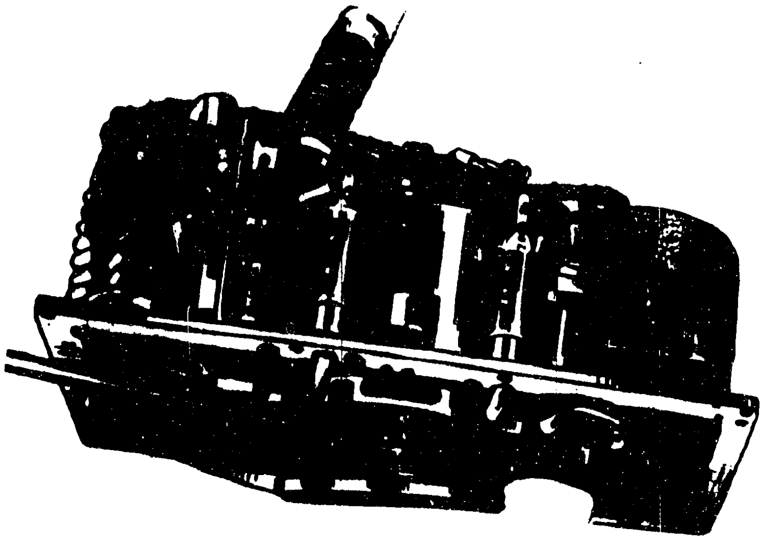

FIG.111. LUBRICATION OF MAIN GYRO UNIVERSAL JOINT AXLES

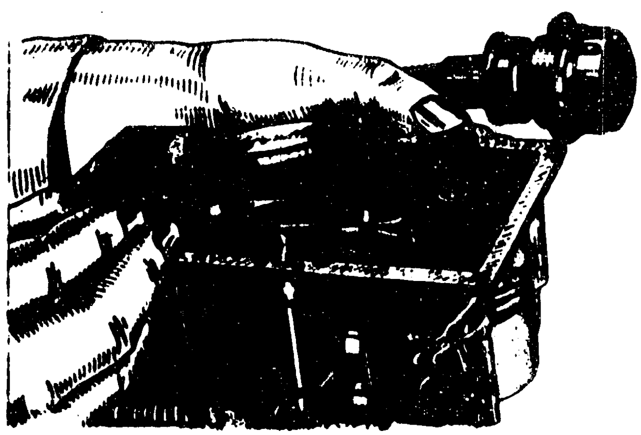

FIG.112. LUBRICATION OF SIGHT HEAD GYRO CENTRAL BEARING

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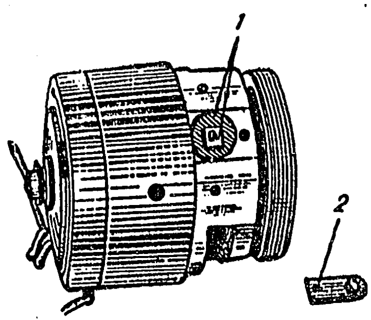

FIG.108. ELECTRIC MOTOR WITHOUT JACKET.
1 = brush holder; 2 = screw.

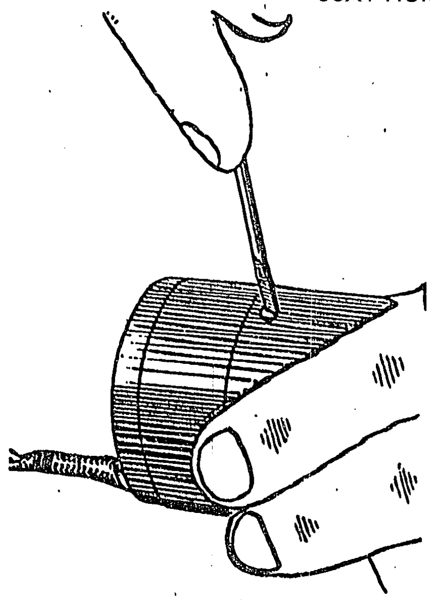

FIG.109.

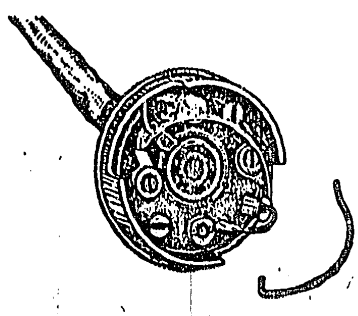

FIG.110

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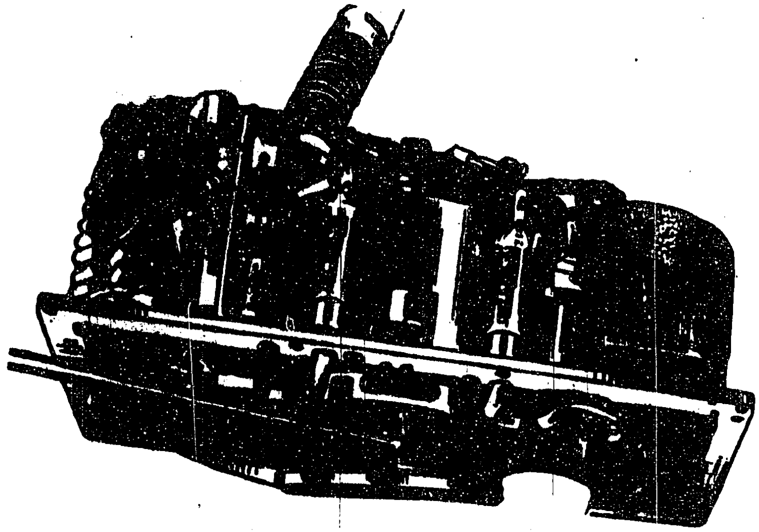

FIG.111. LUBRICATION OF MAIN GYRO UNIVERSAL JOINT AXLES

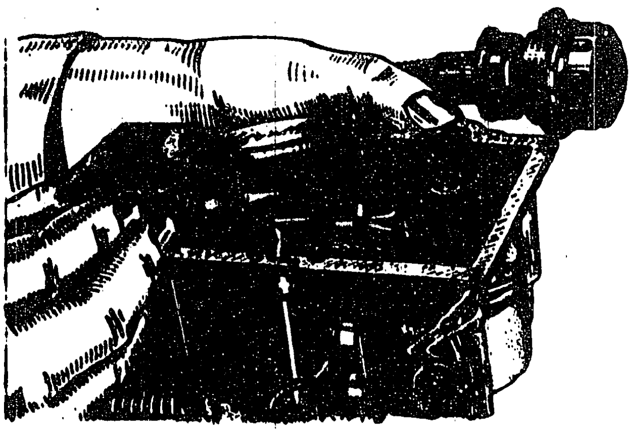

FIG.112. LUBRICATION OF SIGHT HEAD GYRO CENTRAL BEARING

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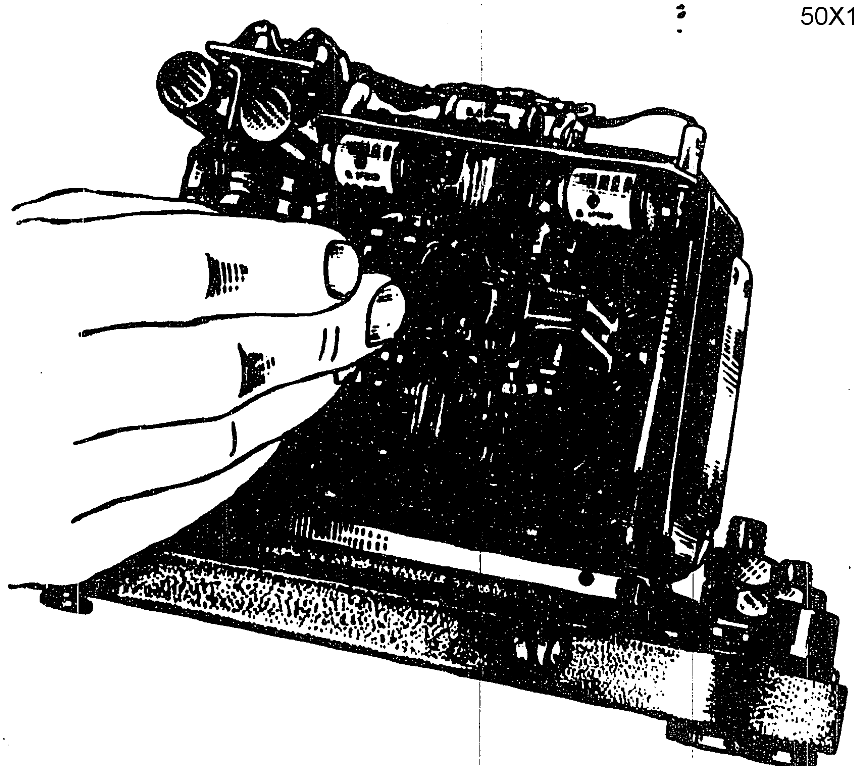

FIG.113. LUBRICATION OF ZERO GYRO UNIVERSAL JOINT AXLES

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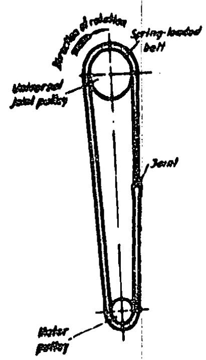

FIG. 114. SPRING-BELT ARRANGEMENT ON PULLEYS

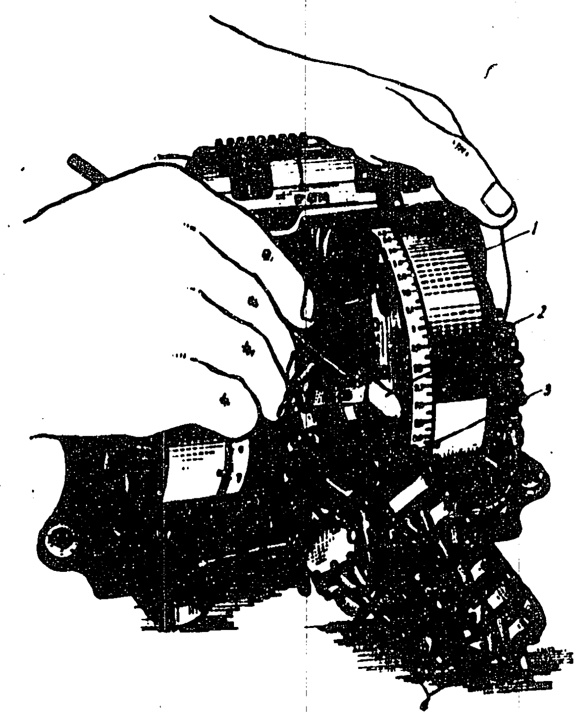

FIG. 115. WASHING OF COMPUTER POTENTIOMETERS
1 – unit T; 2 – scale opening; 3 – attachment screws; 4 – package of adjustable resistors.

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50X1-HUM

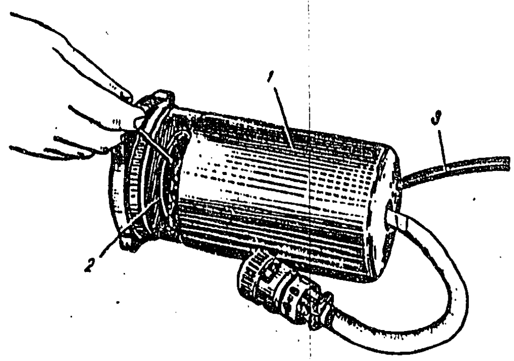

FIG.116. WASHING OF ALTITUDE UNIT POTENTIOMETERS
1 – altitude unit; 2 – potentiometers $П_2$, $П_3$, $П_{10}$; 3 – rubber tube running to КПУ-3.

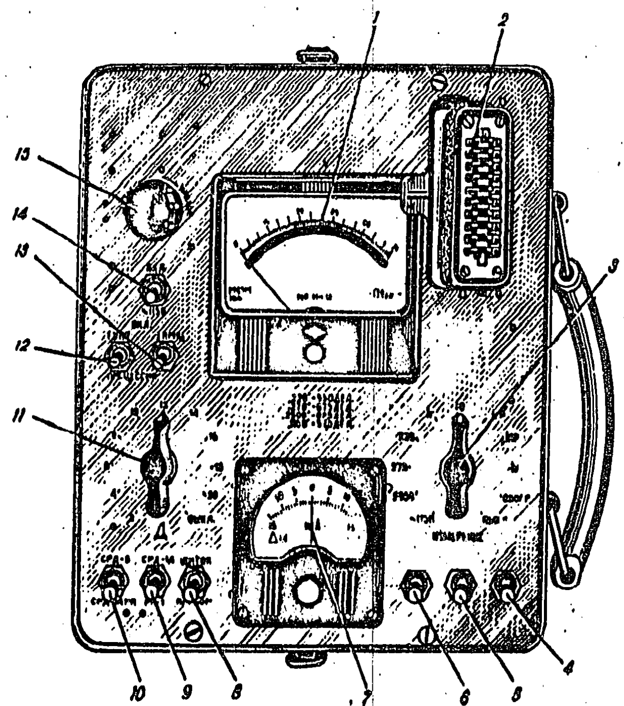

FIG.117. ELECTRIC POWER PANEL ЩЭСМ-3
1 – instrument M-494; 2 – flat connector; 3 – measurement selector switch ПК-1; 4,5,6 – heating circuits selector switches; 7 – milliammeter ПМ-70; 8 – INSTRUMENT-PANEL switch; 9,10 – radar ranging unit type switches; 11 – selector switch of simulator Д; 12 – switch of prediction and correction circuit; 13 – sighting circuit switch; 14 – 115V – ON(115 В – ВКЛ) switch; 15 – manual correction potentiometer.

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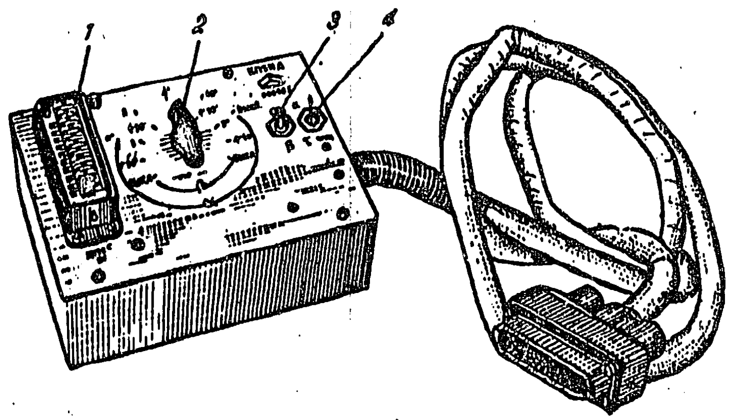

FIG.118. ELECTRIC POWER PANEL КП5НД
1 – flat connector; 2 – selector switch of α and β angles simulator; 3,4 – switches for checking α and β circuits.

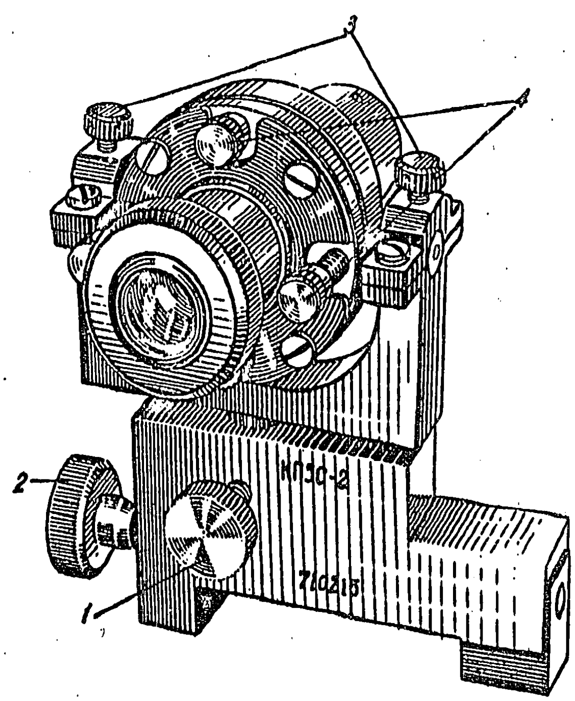

FIG.119. OPTICAL UNIT КП5С-2
1,2 – clamping screws; 3,4 – adjustable screws.

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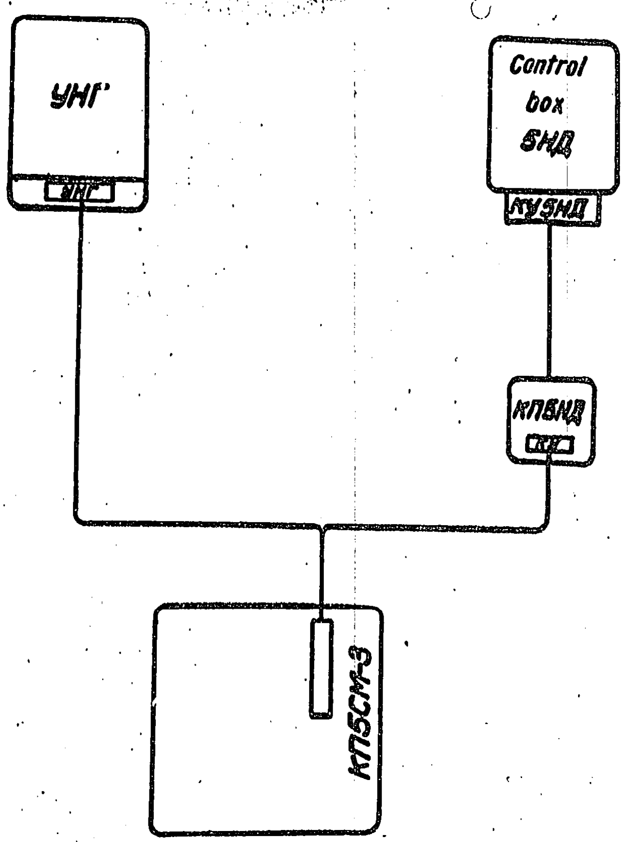

FIG.120. CONNECTION DIAGRAM OF КП5СЛ EQUIPMENT

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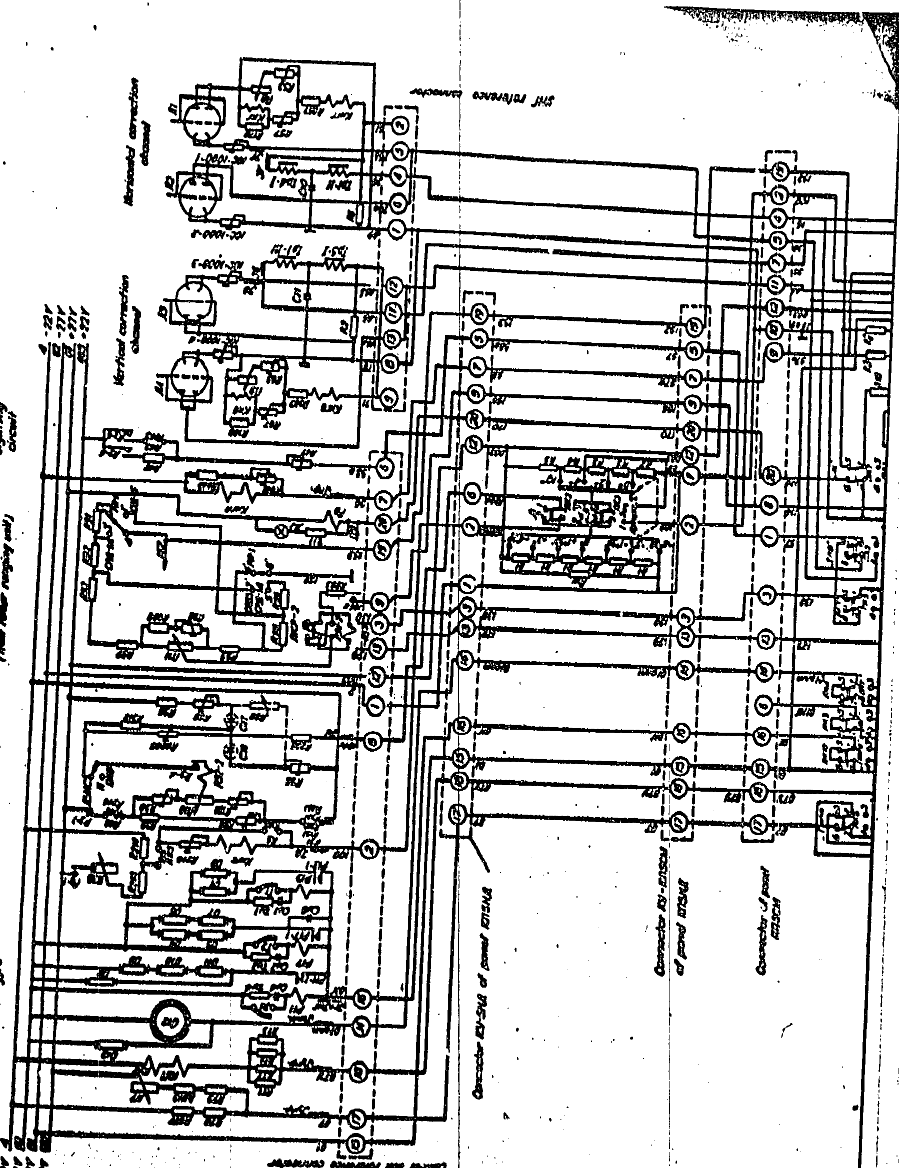
Secret

Inset 9



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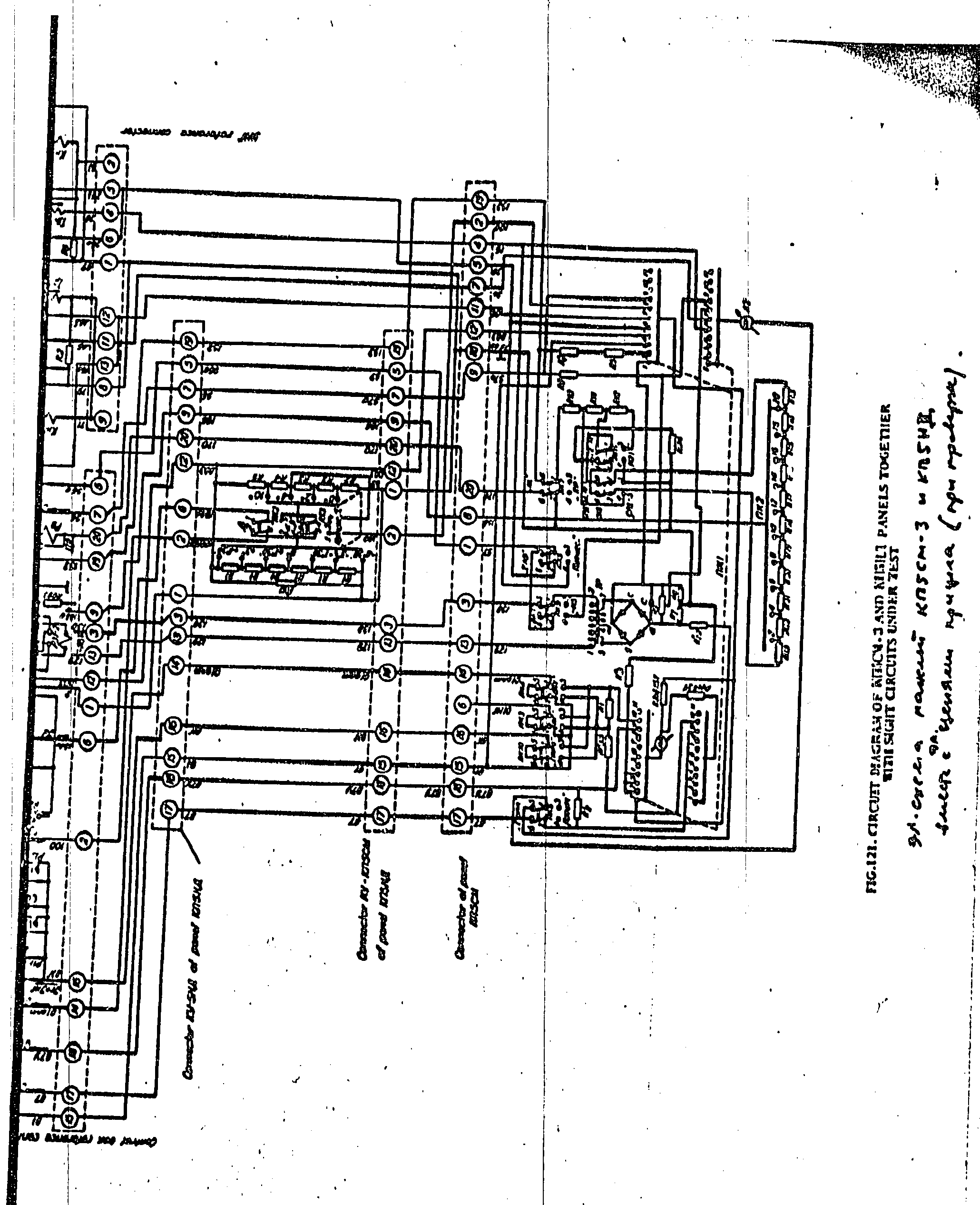

FIG.121. CIRCUIT DIAGRAM OF KПSCM-3 AND KПSHII PANELS TOGETHER WITH SIGHT CIRCUITS UNDER TEST

Эл. схема панелей КПSCМ-3 и КПSHII вместе с эл. цепями прицела (при проверке).

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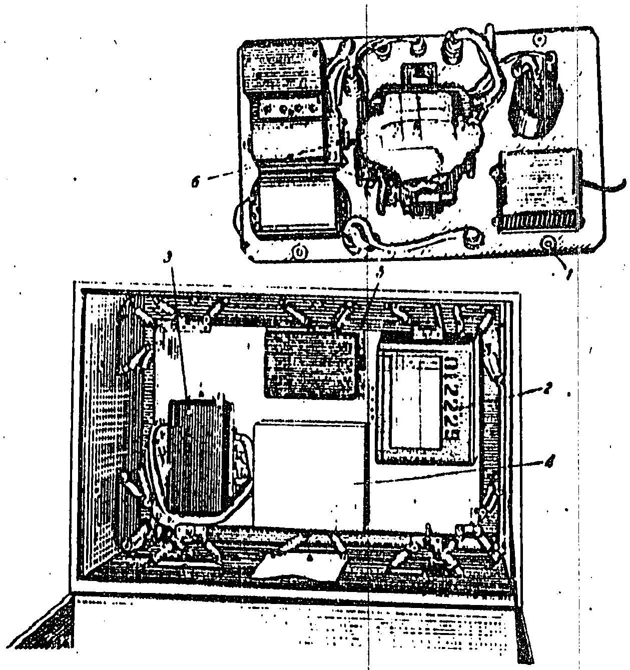

FIG.122. ARRANGEMENT OF INSTRUMENTS IN PACKING CASE (UPPER PLATE REMOVED)
1 – upper plate; 2 – box with SPTRA set; 3 – stop; 4 – box; 5,6 – strips.

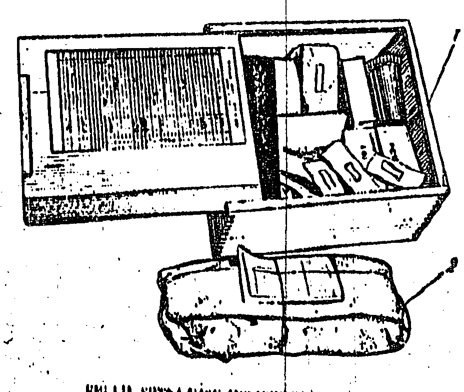

FIG.123. SPTRA CASE AND MOUNTING SET
1 – SPTRA case; 2 – mounting set.

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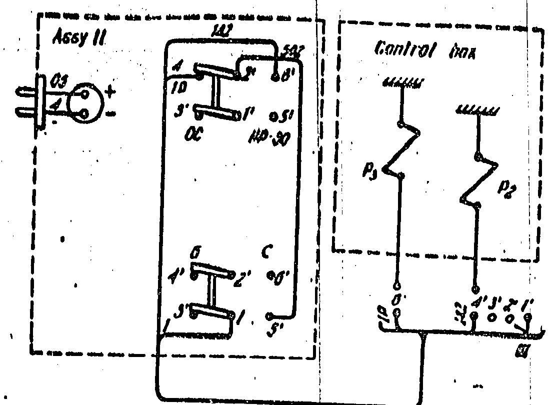

FIG. 124

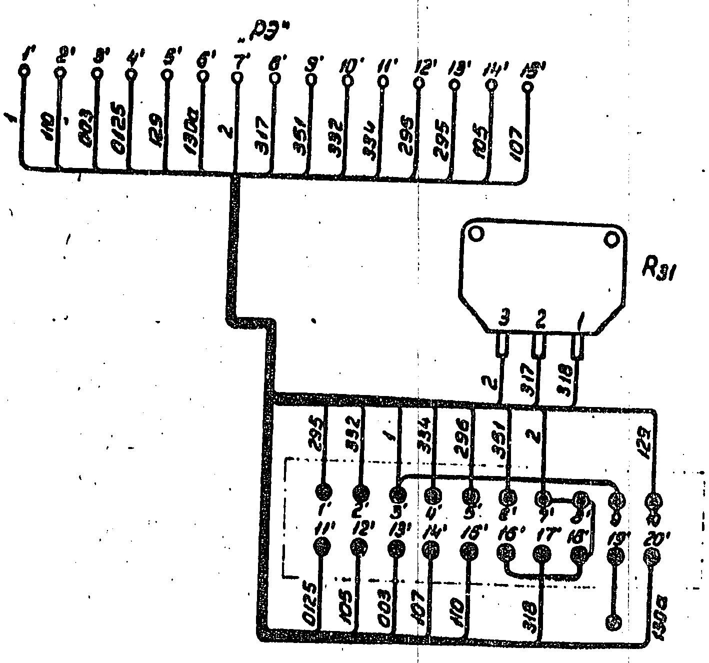

FIG. 125

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50X1-HUM

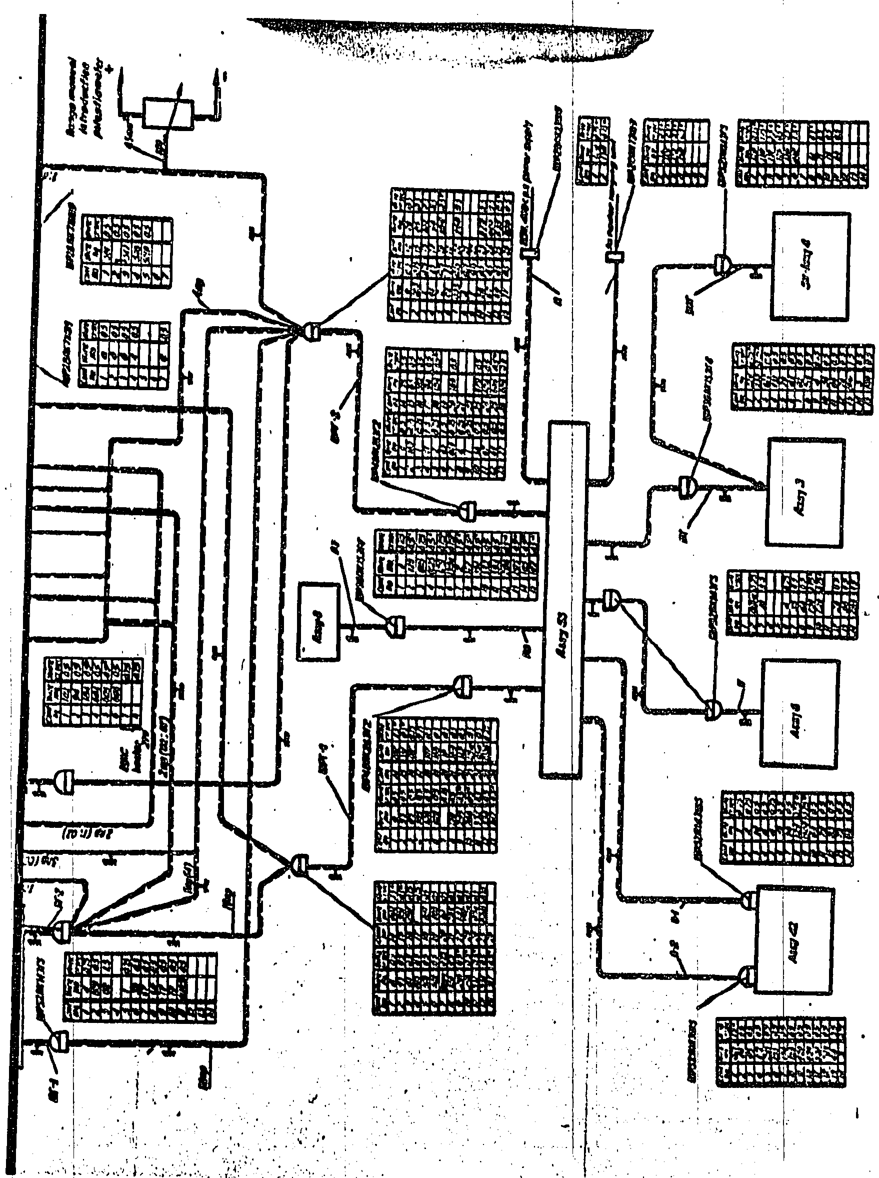

FIG.126. CABLING DIAGRAM
схема кабелей

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[redacted]

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Inset 10

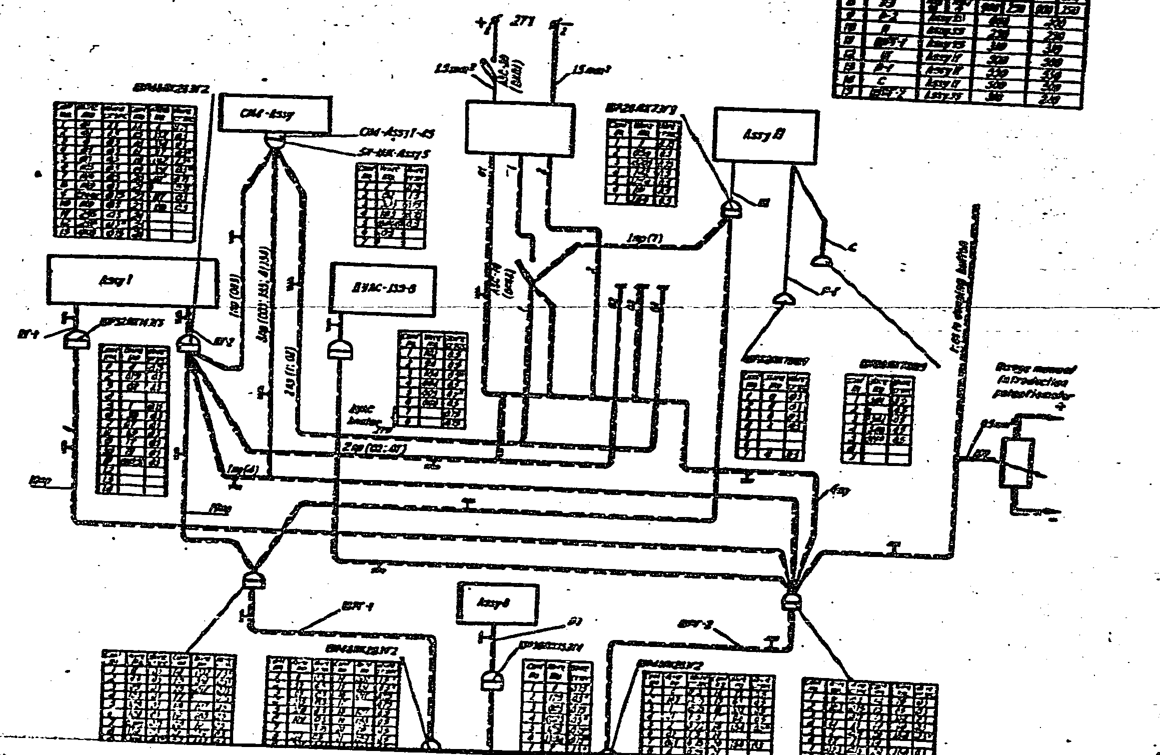
No	Cable designation	Assy	Cable length from Assy to connector	
1	[illegible]	Assy I	500	310
2	[illegible]	Assy I	300	300
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	400	220
10	[illegible]	[illegible]	230	230
11	[illegible]	[illegible]	310	310
12	[illegible]	[illegible]	300	300
13	[illegible]	[illegible]	330	330
14	C	[illegible]	300	300
15	[illegible]	[illegible]	310	210

Symbols
- Connector, receptacle
- Connector, plug
- Shielded wire

Wire cross-section is given in mm²

Purpose of leads in cable C
301 - firing key circuit
342 - [illegible] circuit
348 - B circuit
300 - [illegible] circuit

Purpose of leads in cable P-1
1; 2 (a; b) - signal lamp RADAR BLOCKING UNIT HIGH VOLTAGE ON
3; 4; 7 (3; 2; 4) - switching on high voltage for CPA-5



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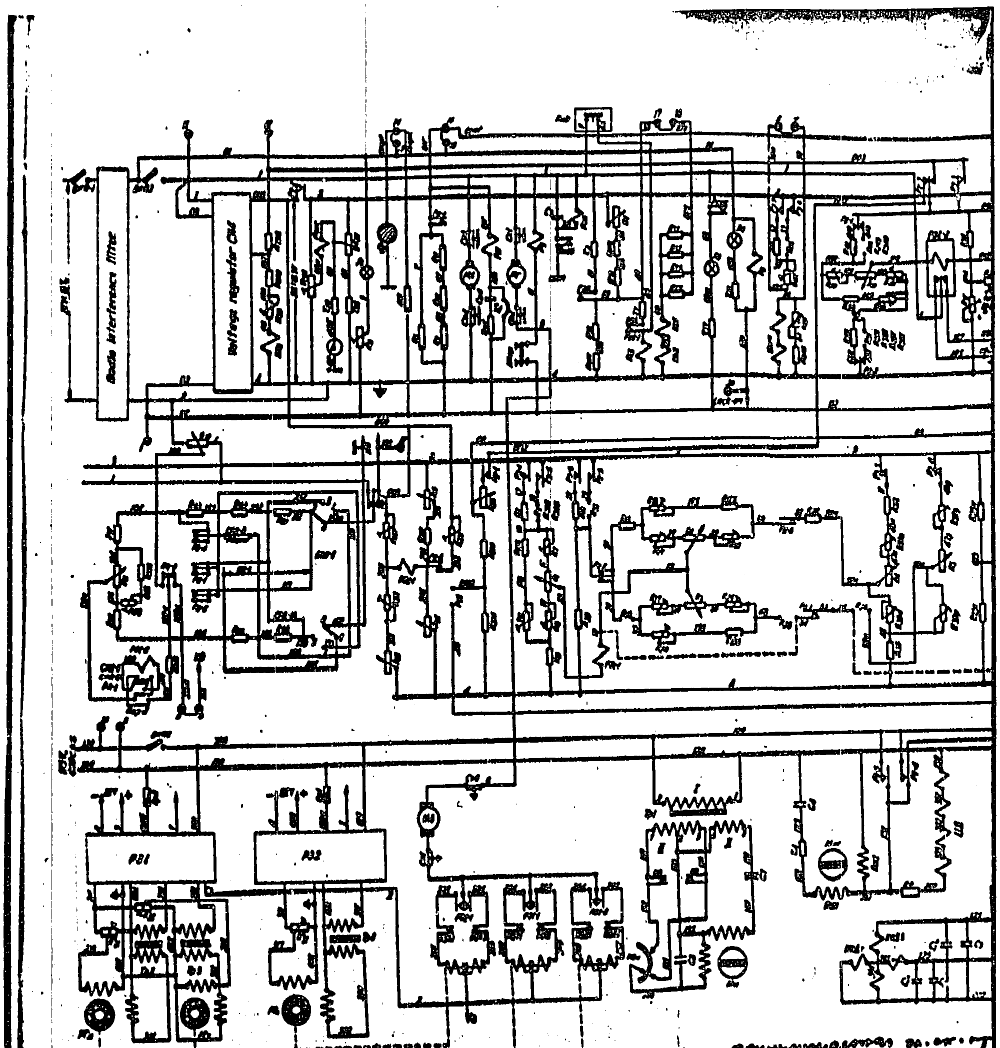

FIG.127. SIGHT KEY DIAGRAM

[redacted]

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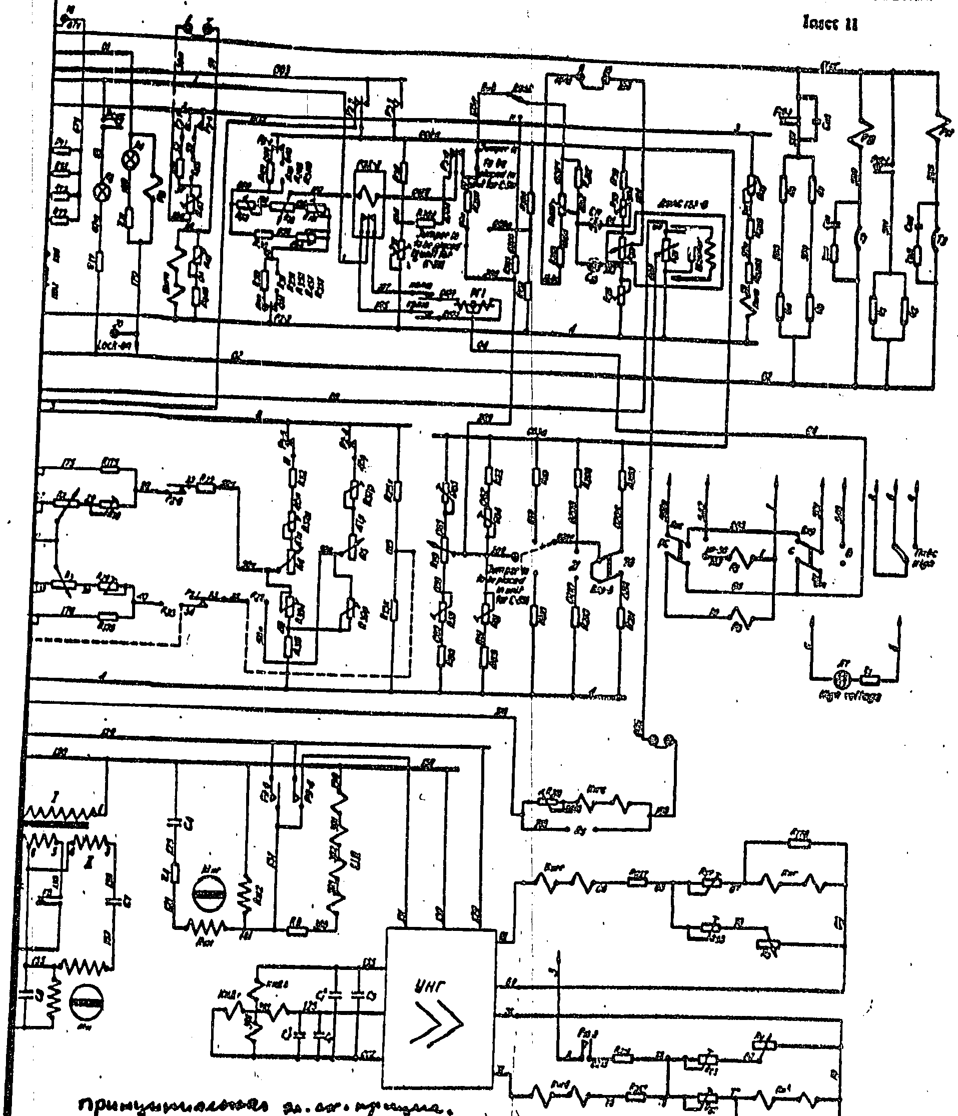
Inset II



Принципиальная эл. схема прицела.

127. SIGHT KEY DIAGRAM

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1126
R213
0213
210
P-15

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SECRET
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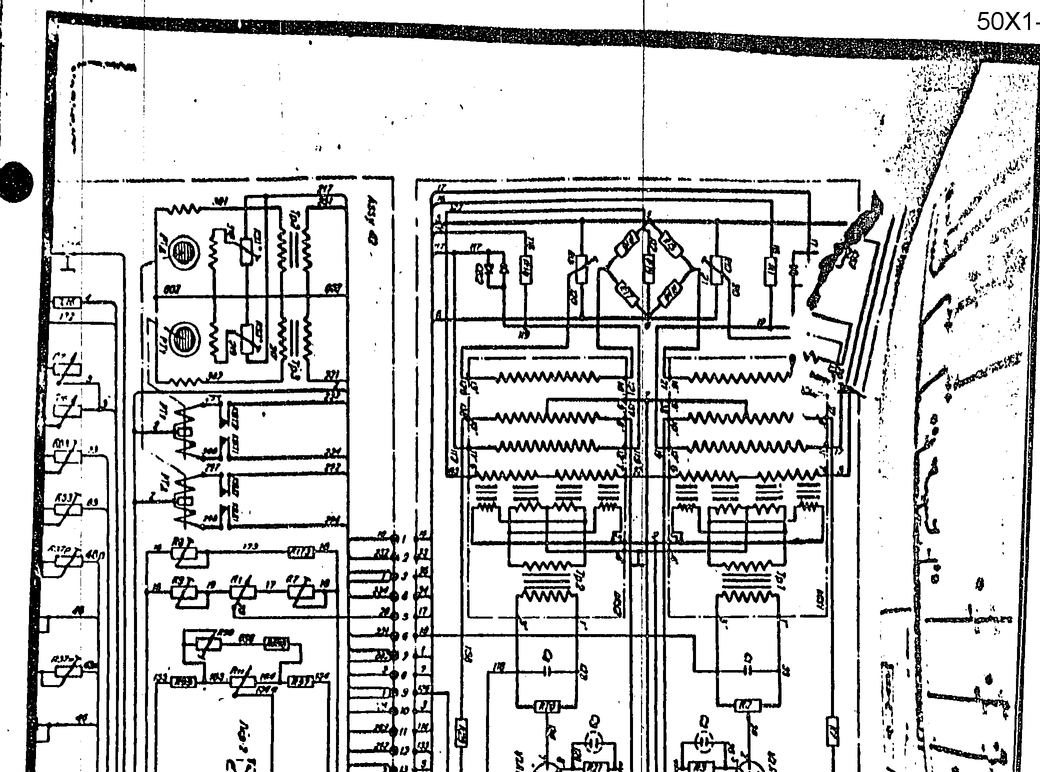

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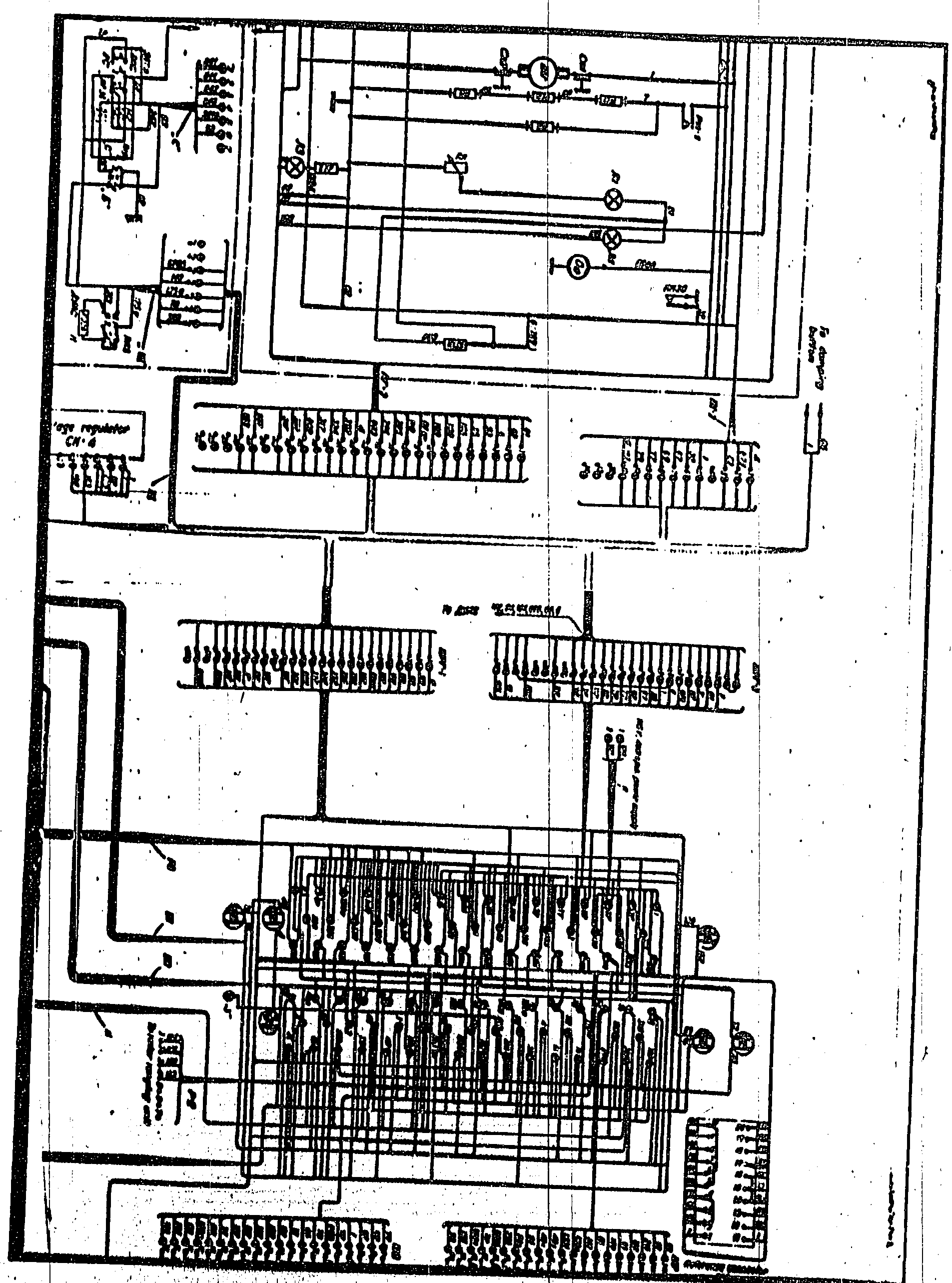

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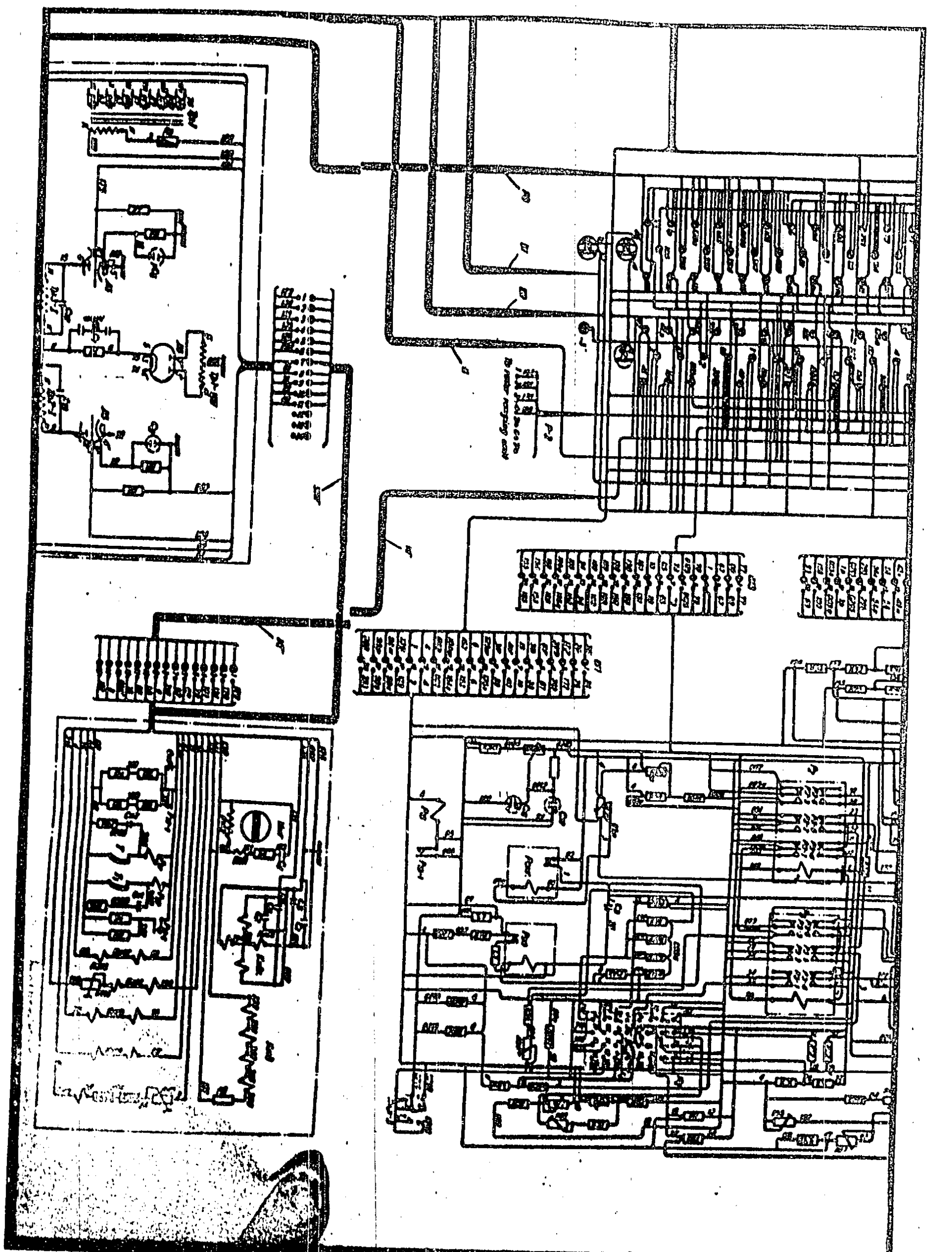

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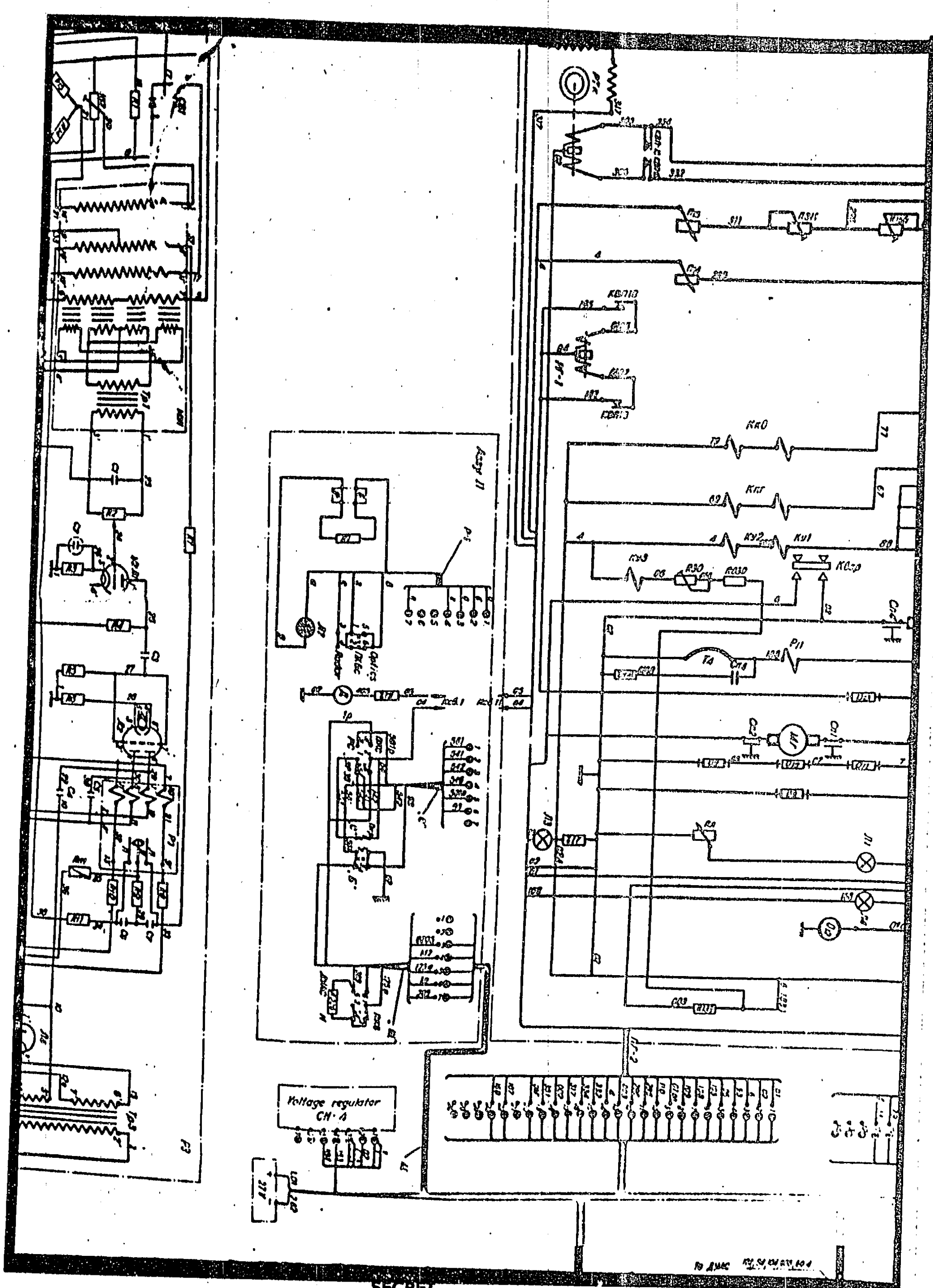

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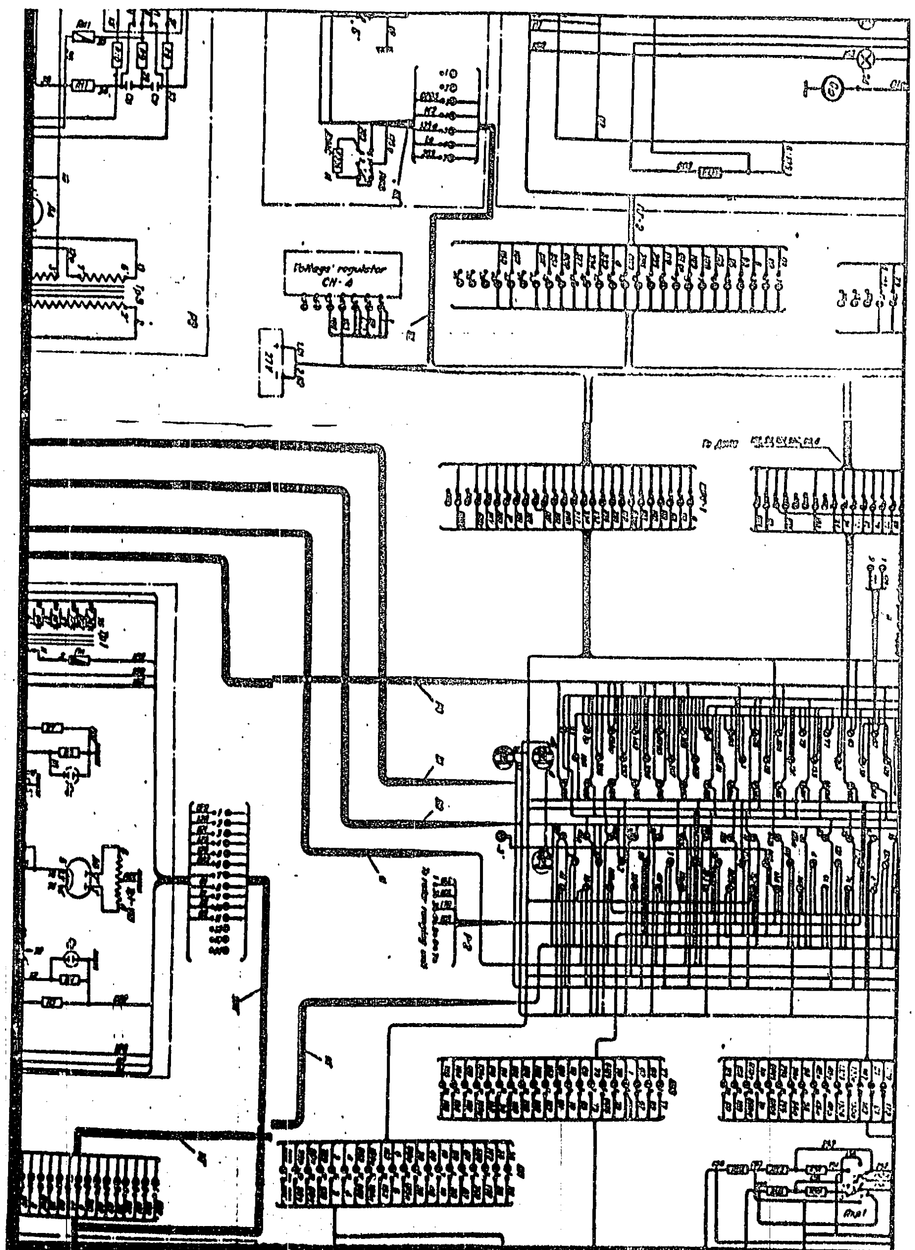

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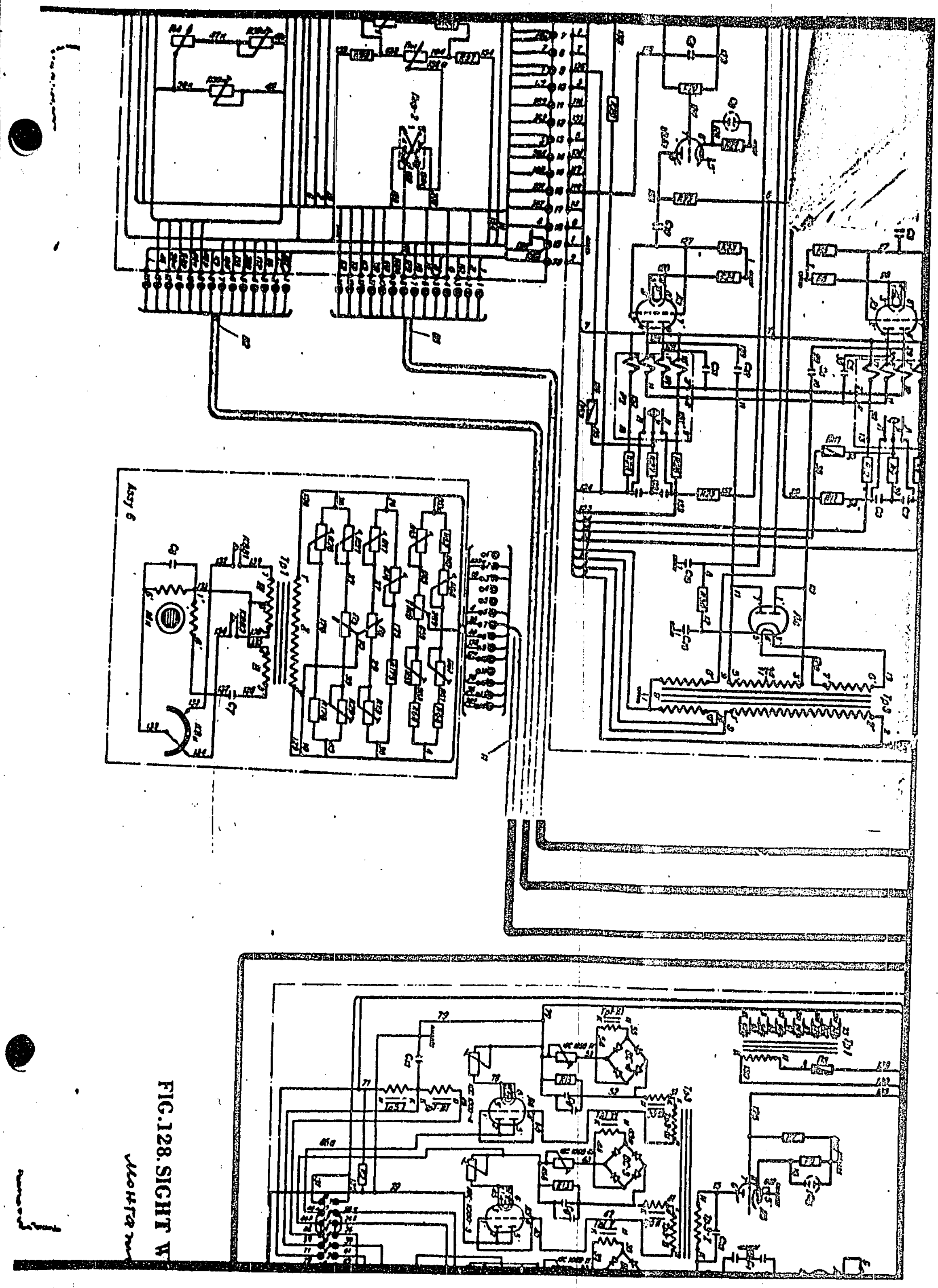

FIG.128. SIGHT W

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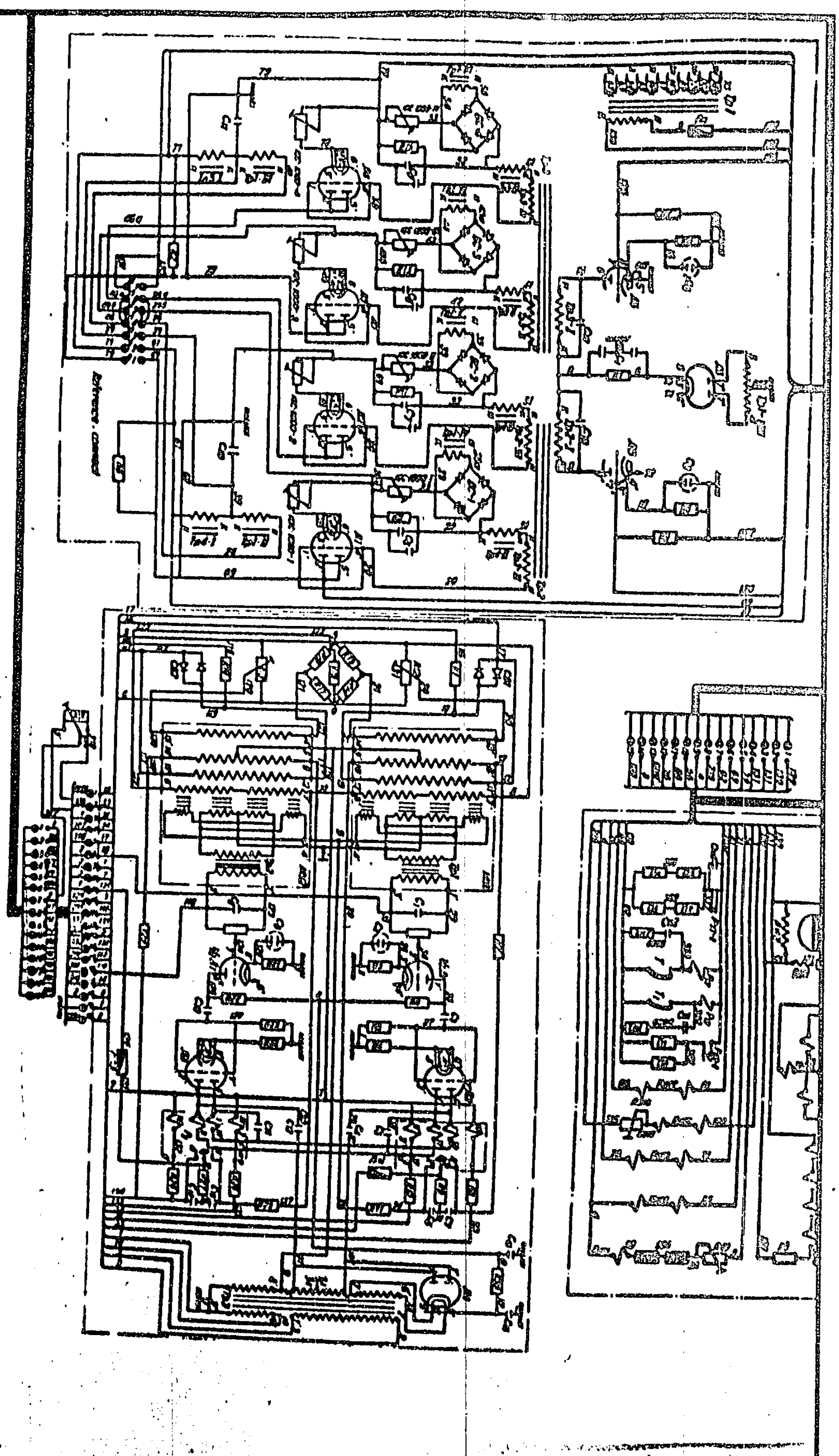

FIG.128. SIGHT WIRING DIAGRAM

монтажная схема прицела

50X1-HUM

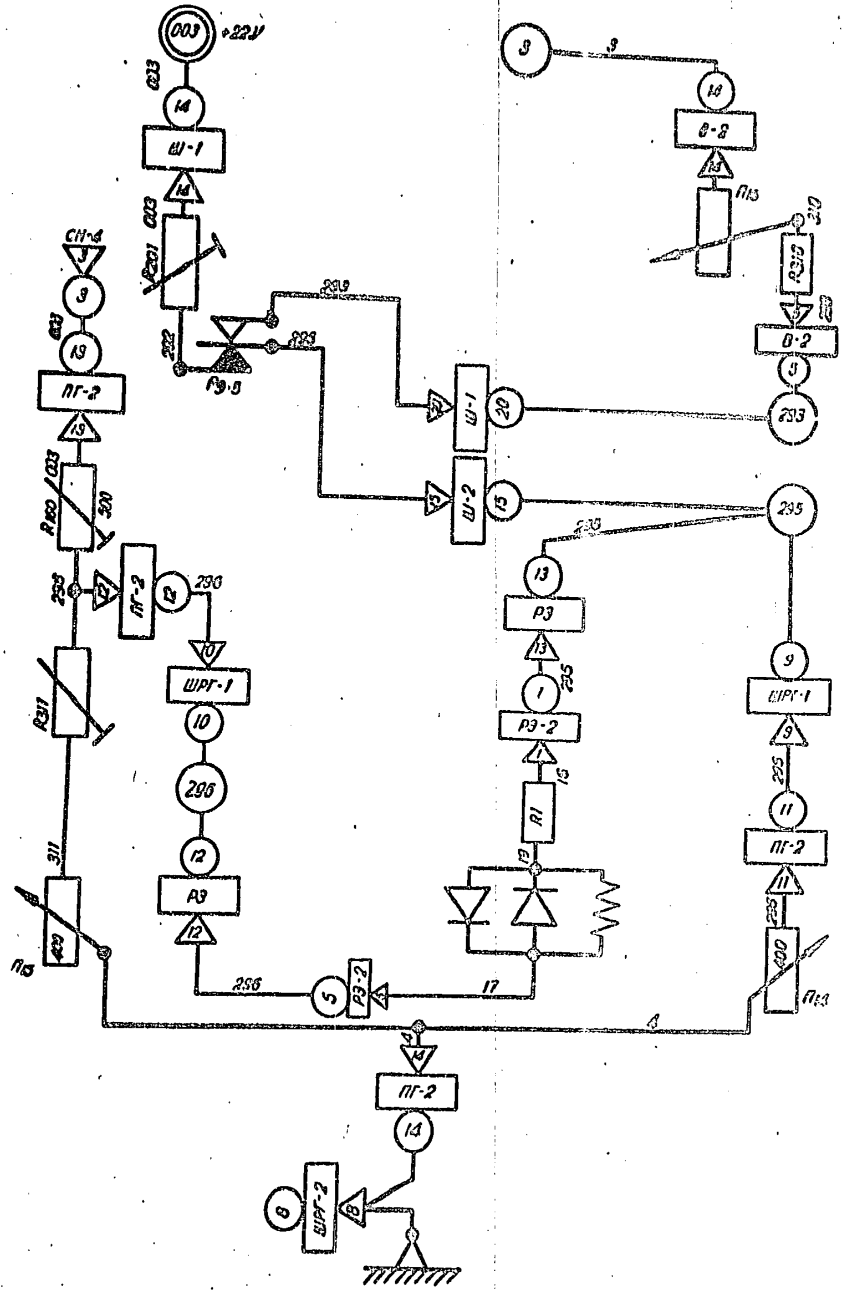

FIG.129. ELECTRIC DIAGRAM OF RETICLE CIRCLE FOLLOW-UP BRIDGE

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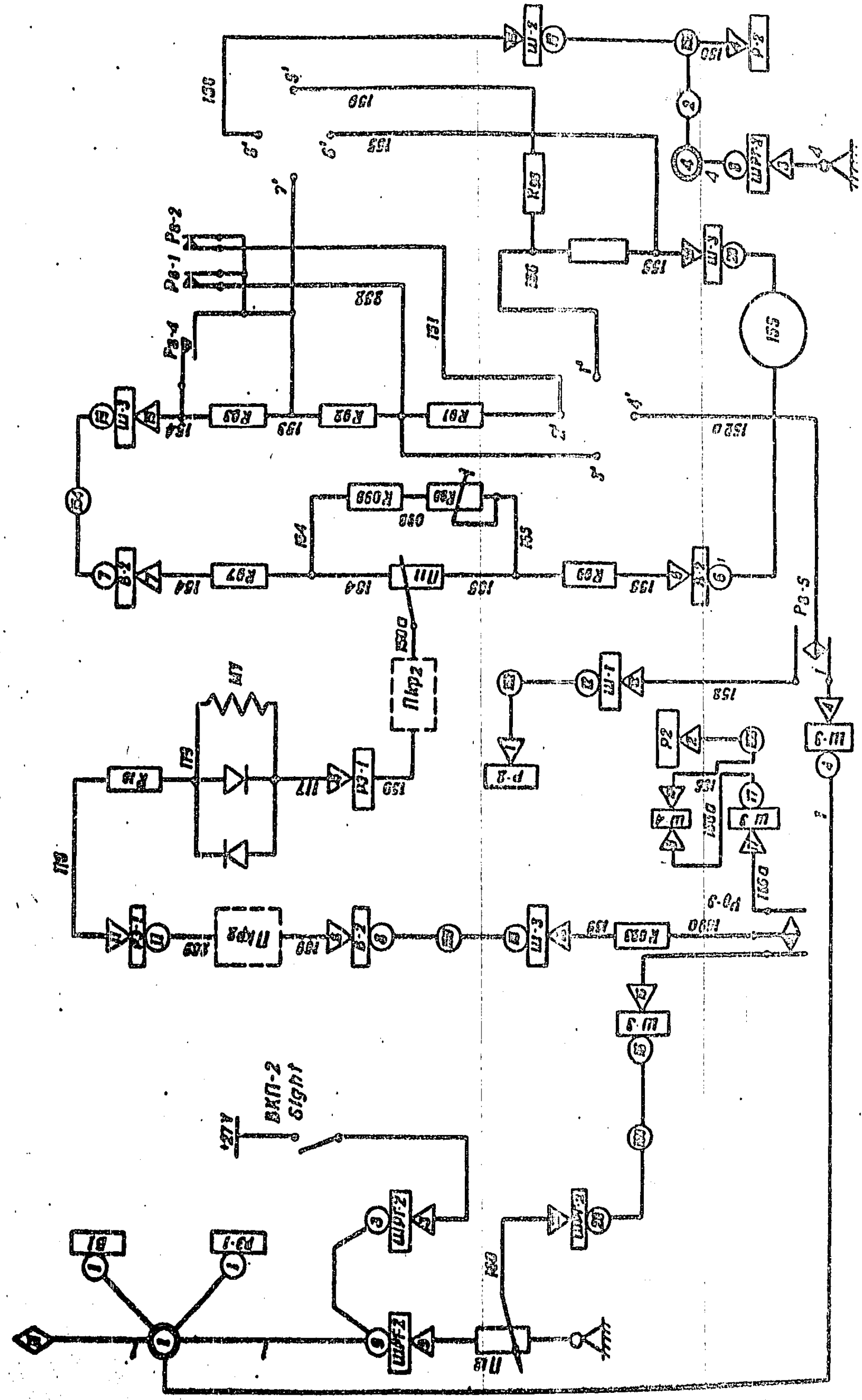

Эл. сх. моста отработки дальности

FIG. 130. ELECTRIC DIAGRAM OF RANGE FOLLOW-UP BRIDGE

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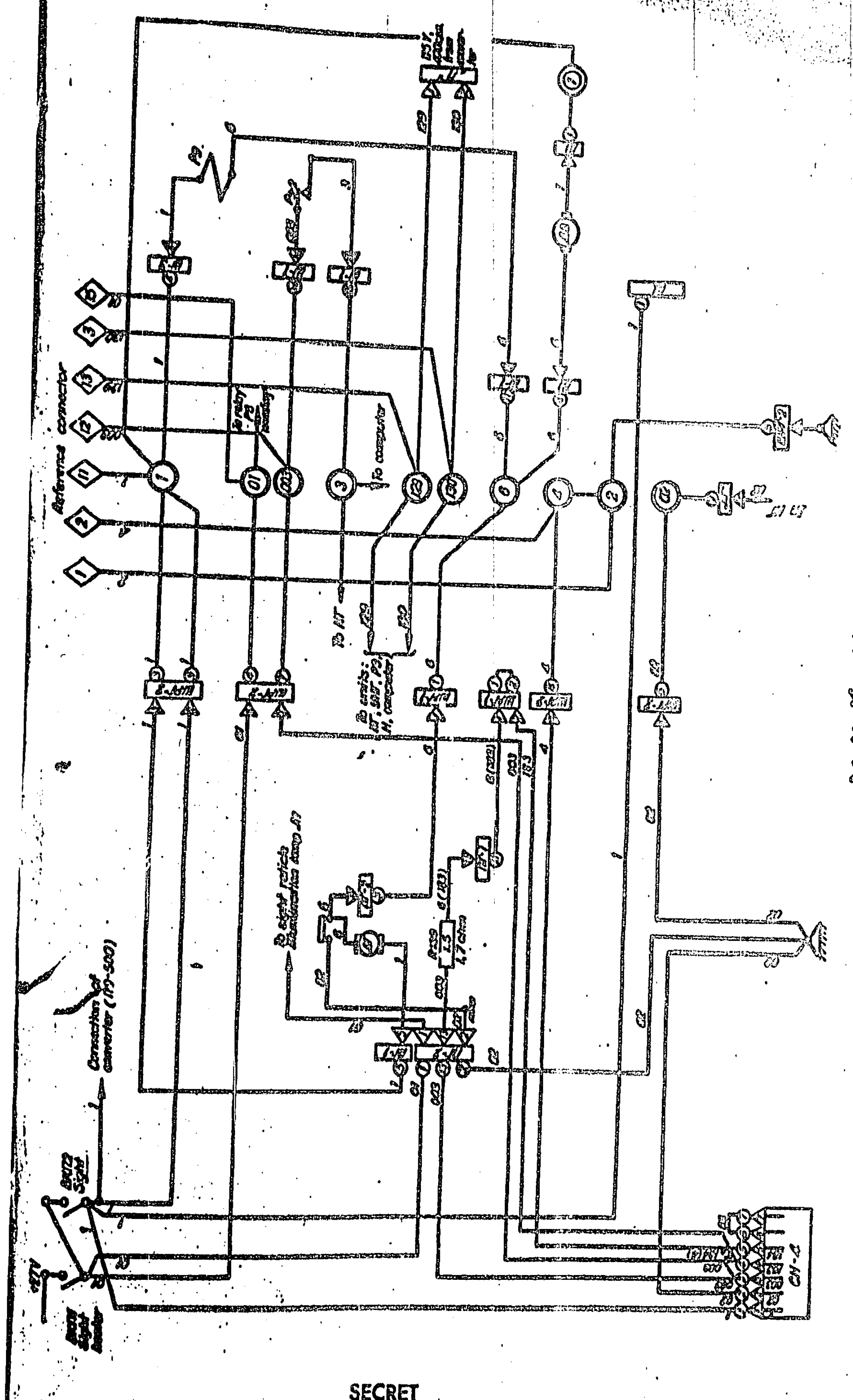

FIG.331. ELECTRIC DIAGRAM OF SIGHT SUPPLY LINES

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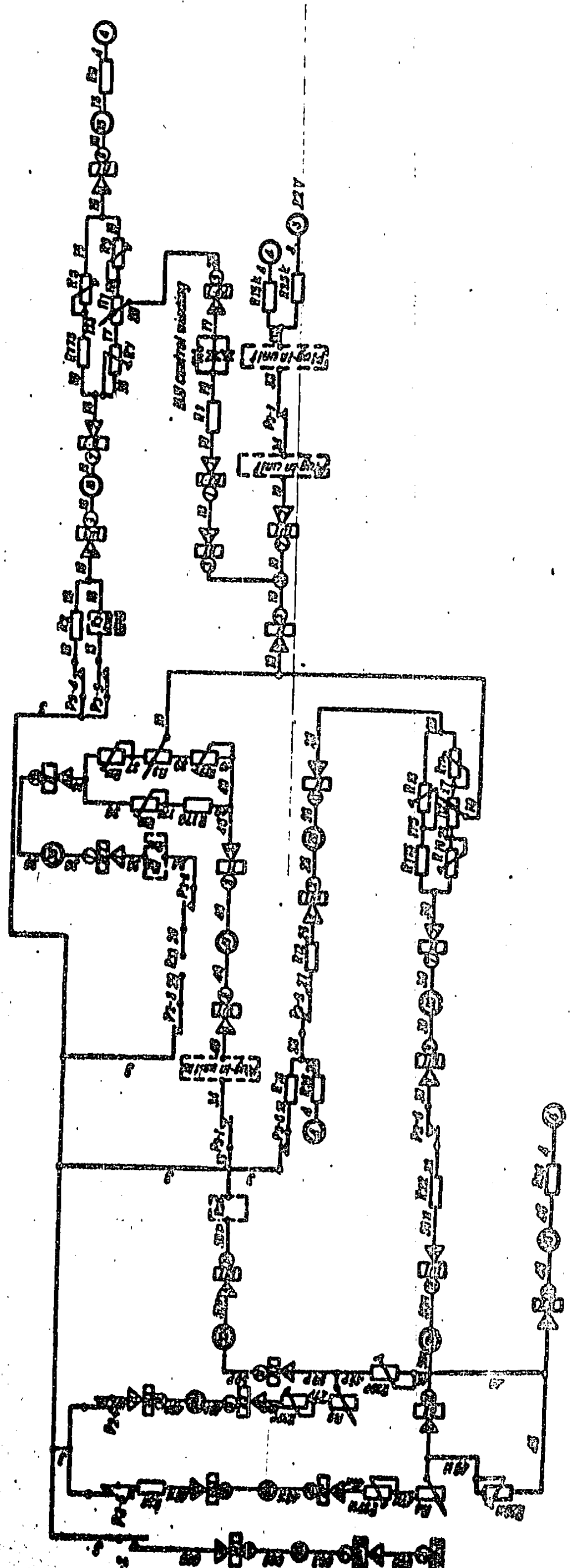

FIG. 132. ELECTRIC DIAGRAM OF THE BALLISTIC BRIDGE

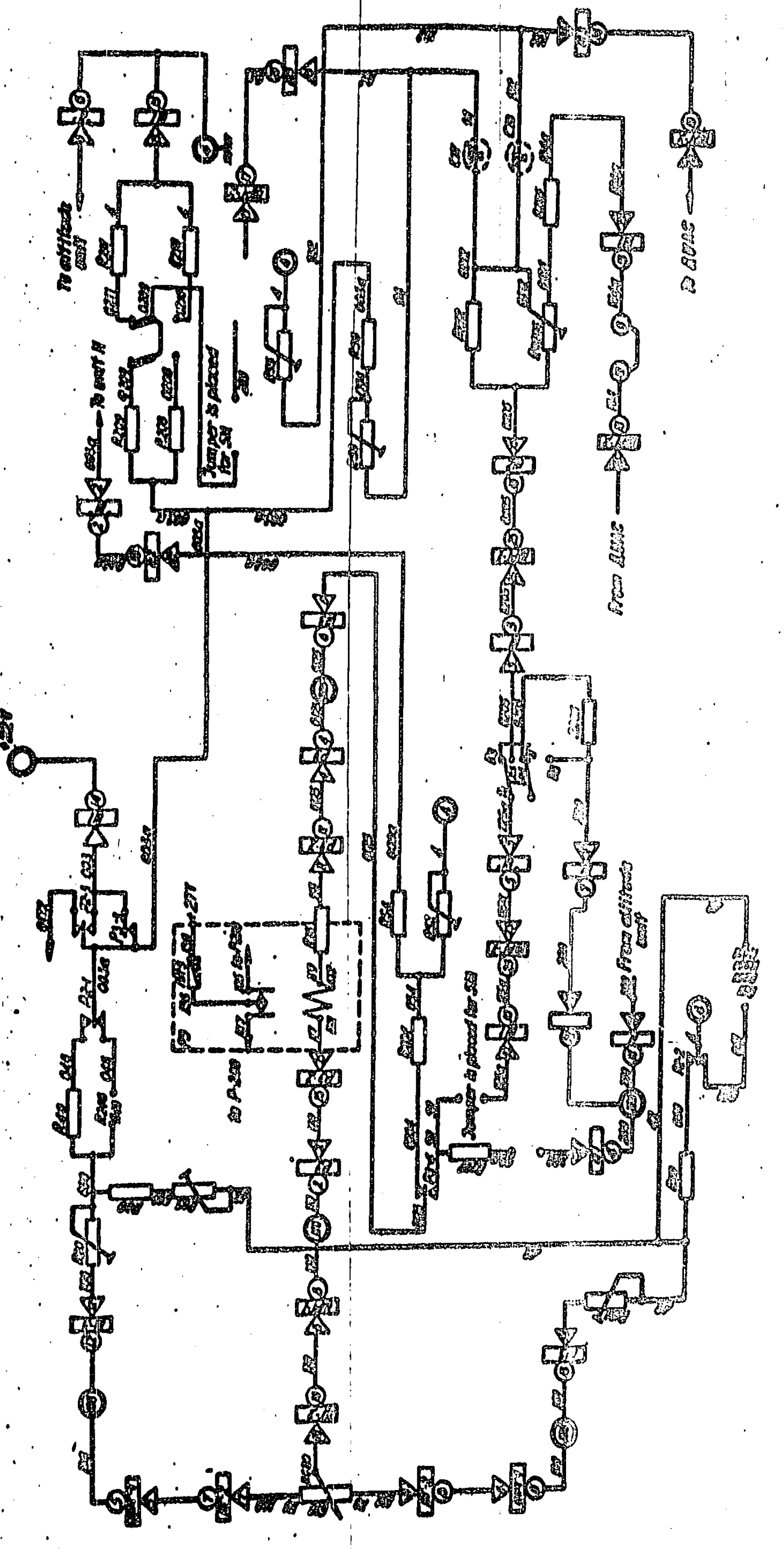

FIG.133. ELECTRIC DIAGRAM OF ATTACK ANGLE (α) CORRECTION FOLLOW-UP BRIDGE

[redacted]

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OVERLOAD WARNING UNIT MP-28A

SECRET

NO FOREIGN DISSEM

GROUP 1
Excluded from automatic downgrading and declassification

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SECRET
NO FOREIGN DISSEM

50X1-HUM

OVERLOAD WARNING UNIT
МП-28А

SECRET
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CONTENTS

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50X1-HUM

I. PURPOSE AND OPERATING PRINCIPLE

The overload warning unit, model МП-28А (Fig.1), is intended for showing the overloads appearing on the aircraft.

The operation of the overload warning unit is based upon the principle of spring balance. The overload involves an inertia of weight 2 (Fig.2) suspended on springs 1 and 5 whose resilience counterbalances the inertia.

The inertia force causes a displacement of weight 2 and brushes 4 and 6 rigidly connected with the weight and sliding along fixed collectors 3 and 7.

When ~~the unit~~ comes to indicate the overloads involved, it breaks the circuit running between the contacts and current-conducting portion of collectors 3 and 7.

The power supply is brought to plug connector 8 whose terminals are connected to collectors 3 and 7 and brushes 4 and 6 by means of electric cables.

The electric circuit of the warning unit is illustrated in Fig.3.

II. MAIN TECHNICAL DATA

1. The overload warning unit is intended to separately indicate two values of the overload:

$$n_1 = +1.6\ g; \quad n_2 = +2\ g.$$

2. The contacts of the warning unit switches operate to break the circuit. The load of the switch contacts is relay ТКЕ52-ПД.

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3. The voltage of the current supplied to the relay mentioned reaches 27 V $\pm$ 10% D.C.

4. The overload indicating error under normal temperature does not exceed $\pm$ 0.1 g.

5. The overload indicating error under temperatures of $\pm 60^{\circ}$C and $+150^{\circ}$C (applied not longer than 5 minutes) does not exceed ± 0.15 g.

6. The frequency inherent in the inertia portion of the overload warning unit ranges between 7 and 15 cycles per second.

7. The overload warning unit remains vibration-proof under vibrations with 20 to 200 cycles per second frequency and overloads of 1.5 to 4.4 g, provided the amplitude does not exceed 1 mm.

8. The overload warning unit is operative, when the overloads of 1.5 g are applied along two side axes, the error involved in this event not exceeding 0.15 g.

9. The overload warning unit can withstand 10,000 shocks per minute without impairing the performance of the instrument, provided the shocking rate does not exceed 60 to 100 shocks per minute, and the overload, 4 g.

10. The contacts of the overload warning unit servicing the relay ТКЕ52-ПД can withstand 25,000 opening operations throughout the guaranteed period of the instrument service life.

11. The insulance of the electrical components of the overload warning unit relative to the body has the following values:

(a) 20 megohms at minimum under the temperature of $+20\pm5^{\circ}$C and the relative humidity keeping within 30 to 80%;

(b) 2 megohms at minimum under the temperature of $+20\pm5^{\circ}$C and the relative humidity keeping within 95 ± 3%.

12. Under the conditions of normal temperature and relative humidity of 30 to 80%, the insulance of the overload warning

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unit can withstand the puncture test by 500 V, 50 c.p.s. A.C. with the power of the supply source being 5 kWA at minimum.

13. The weight of the overload warning unit does not exceed 1.1 kg.

III. CONSTRUCTION

The sensitive element of the overload warning unit is weight 1 (Fig.4) suspended with the aid of the system of flat springs 6 by the cantilever-type attachment.

Springs 6 are connected to weight 1 by means of two strips 56 and four screws 55. The springs are secured to blocks 7 and 9 by the cantilever-type attachment with the aid of strip 57 and three screws 58. Block 9 is secured to cover 36 with the aid of three screws 37.

Installed inside body 19 is magnetic damper intended for absorbing the oscillations inherent in the inertia mass. The magnetic damper is made up of two cores 21 and 22, magnet 20 and cover 36. The position of the cores relative to each other is fixed with the aid of two lockpins 30. Screw 23 is used for attaching the cores to each other. Cover 36 is attached to core 21 with the aid of two supports 35 and four nuts 34 screwed onto the both sides of the supports.

Arranged in the field of magnetic damper is copper sleeve 24 secured to weight 1 by means of four screws 26. Slots made in sleeve 24 are meant for receiving strips 49 and 68, each secured to weight 1 by means of two screws 25. Screws 44 are made use of for locking blocks 50 and 67 to strips 49 and 68. Inserted into blocks 50 and 67 are contacts comprised of bushing 38, pipe 40 and contact brushes 43 soldered to the latter.

The contact pressure in the bushings of the contacts is adjusted with the aid of a special slit. The contact pressure having been adjusted, the contacts should be locked by two screws 39.

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As copper sleeve intersects the magnetic lines of force, an induction current appears there. The electromagnetic field of the induction current interacts with the magnet field to generate a braking force proportionate to the speed of crossing the magnetic lines of force, i.e. to the speed of movement.

For indicating the two values of the overload, the warning unit is provided with two collectors 66 and 75 made up of insulation and metal plates. Contact brushes 43 connected with weight 1 slide over the surface of the said plates.

Slots made in the insulation plates of collectors 66 and 75 ensure a vertical displacement of the latter required by the adjustment.

At preset overloads, contact brushes 43 change from the metal (current-conducting) plates of the collector over to the insulation plates thereby breaking the electric circuits of the warning systems connected to the instrument (the overload warning unit being intended for use with the relay TKE52-ПД).

Two screws 48 are used for securing collector 75 to angle piece 74 which is in turn attached to block 69 by means of two screws 73. Other collector 66 is fixed to angle piece 62 by means of two screws 65, two screws 63 securing this angle piece to cover 36.

The travel of weight 1 beyond the limits indicated by the instrument is limited by two stops. One of these stops is screw 72 screwed into strip 70 which is attached to weight 1 with the aid of two screws, and the other stop is screw 41 driven into block 69 which is secured to cover 36 by means of two screws 71. Screw 41 is held in place on block 69 by means of nut 42.

Attached to cover 36 with the aid of screws 51 are two insulating blocks 52 and 64 provided with stems. The leads of blocks 50 and 67 as well as the stems of blocks 52 and 64 are connected by springs 45 serving as current conductors.

The collector leads are joined to the terminals of plug connector 47 by means of cables 46. The connecting bunch of the cables is placed inside sheathing coat 27. One end of the sheathing coat is soldered to washer 14, and the other, to cap 18 inserted into plug connector 47 together with pin 17 carrying cables tied to it by thread.

The cables are tightly held in the opening of body 19 by three sealing wedges 13 inserted into the opening and secured there by means of nut 16. Spring 15 arranged in the opening of nut 16 is intended to protect the cables against sharply bent loops. The cables are held close to the walls of body 19 by means of two clamps 60, four screws 61 and nuts 59.

Cover 36 and the components mounted on it are locked to body 19 with the aid of four screws 54.

The hole made in housing 8 and the threaded hole made in weight 1 are intended for caging purposes and for checking the overload warning unit.

The warning unit is caged (the weight is fixed) through the hole made in housing 8 with the aid of stop 4. One end of the stop is screwed into the threaded hole of weight 1, and the other, tightened by nut 5 turned onto threaded bushing 3.

Threaded bushing 3 is attached to housing 8 by means of three screws 2. Nut 5 is locked with screw 33 to obviate inadvertent unscrewing under the conditions of heavy vibrations in the place of installation.

One end of supports 53 is screwed into cover 36, and the other is provided with threaded hole for securing housing 8 with the aid of two screws 32. Sealing cap 31 should be placed under one of screws 32.

Placed between housing 8 and body 19 of the overload warning unit is rubber gasket 12 meant for keeping the dust off the instrument. The rubber gasket is attached to the body by means of strip 11 and two screws 10.

Attached to body 19 with the aid of two screws 28 is name plate 29 specifying the index of the overload warning unit, the range of the overloads shown by the instrument, the voltage of the power supply required, the trade symbol, and the serial number of the warning unit. Sealing cap 31 is filled with sealing putty bearing the stamp of the Inspection Department.

The overall dimensions of the overload warning unit are specified in Fig.5.

IV. OVERLOAD WARNING UNIT SET

No.	Description	Quantity, pc.
1	Overload warning unit	1 pc.
2	Calibrating unit (one per 4 warning units)	1 pc.
3	Stop	1 pc.
4	Certificate	1 copy

V. INSTALLATION ABOARD AIRCRAFT

W A R N I N G! Prior to starting to install or operate the overload warning unit be sure to uncage the instrument. For this purpose, remove nut 5 (Fig.4), unscrew stop 4 used for caging the sensitive element, screw nut 33 again and secure it with the aid of screw 33.

Before proceeding to the installation of the overload warning unit aboard the aircraft.

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1. Check the vibration at the place of installation of the overload warning unit seeing that it does not exceed the permissible limits (See Para. 7 of Section II).

2. Examine the overload warning unit and check:

(a) whether there are evidences of outer defects or damage of the exterior parts;

(b) whether the marking is correct;

(c) whether the Certificate has been properly filled in;

(d) whether there are any parts missing.

3. Subject the overload warning unit to a checking test with a view to:

A. determining the indication error of the instrument under $+20^{\circ}C$ temperature. For this purpose:

- level base plate 2 (Fig.6) with the aid of three bearing screws and check the adjustment making use of level 1 or a plumb;

- mount the warning unit on base plate 2;

- connect the overload warning unit to power plant 5 as it is shown in Fig.7;

- unscrew nut 5 (Fig.4) and screw calibrating unit 3 into weight 1 (Fig.6) through the hole made in housing 8;

- put a set of weights 4 on calibrating unit 3 until the lamp comes on (i.e. starts flickering);

- determine the value of the weight (in terms of *gr*) involving a flickering of the lamp under the overloads of +1.6 *g* and +2 *g*.

Set the weight with an accuracy of up to 0.5 *gr*;

- calculate the error making use of the following formula:

$$n_1 = \frac{0.6p_o - p_n}{p_o};$$

$$n_2 = \frac{p_o - p_n}{p_o},$$

where:

n_1 and n_2 - errors of the instrument;

p_o - reduced weight of the instrument (Certificate datum);

p_n - total weight of the calibrating unit and set of weights involving an operation of the instrument (in gr).

The error of the overload warning unit must not exceed ±0.1 g.

B. determine the insulance of the electrical components of the overload warning unit relative to the body under the conditions of normal temperature and relative humidity ranging between 30 to 80%. For this purpose, connect one wire of the megger rated for 500 V D.C. to the shorted terminals of the connector plug, and the other end, to its body.

Install the overload warning unit aboard the aircraft in accordance with the aircraft equipment arrangement diagram, directing the loads to be measured and the sensitivity axis of the warning unit in the same way.

Note: The pointer engraved on the name plate of the warning unit indicates the direction of the overloads the unit shows.

Mount the overload warning unit. To this effect:

(a) set the instrument properly relative to the aircraft symmetry axis referring to the side marks made on the body.

(b) fix the warning unit on the assembly, it has been installed on with the aid of four screws.

(c) connect the overload warning unit to the electric mains.

This done, check the performance of the instrument. While doing so, unscrew nut 5 (Fig.4), drive calibrating unit into weight 1 through the hole made in housing 8, and apply hand-pressure to the calibrating unit to check the indication of the overload.

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VI. OPERATION OF OVERLOAD WARNING UNIT

In the course of operation, the overload warning unit should undergo a test once every six months, as it is instructed in Section V.

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A. Troubles and Remedies

Trouble	Cause	Remedy
Warning unit operates without application of load	1. Faulty soldered joints between plug connector current conductors, collectors and contacts	1. Unscrew housing 8 (Fig. 4), check the soldered joints for defects, solder up the conductors, and screw the housing on
		2. Unscrew nut of plug connector 47, solder the conductors up, and turn the nut on
	2. No contact between brushes and collector	3. Unscrew housing 8, wipe collectors 66 and 75 with a piece of dry cloth, and brushes 43, with a piece of cloth wetted in alcohol, and then adjust the contact pressure
	3. Current-conducting spring broken	

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1	2	3
		4. Unscrew housing 8, unsolder spring 45 and replace it
Unit indicates overloads exceeding the permissible limits	Instrument maladjusted	Carry out partial disassembly and adjustment of unit
Unit indicates overloads below the permissible limits	Same	Same

B. Disassembly

Disassemble the overload warning unit only after locating the defects rendering the instrument absolutely unserviceable (the errors in excess of the permissible limits, grave mechanical damage, and suchlike).

Be sure to uncage the warning unit before proceeding to disassemble the instrument. While carrying out the disassembly, handle the instrument with utmost care using authorized tools which must be kept in good order ready for immediate use.

If the maladjustment of the warning unit has been detected during the operation, carry out partial disassembly of the instrument. To this effect, take out housing 8, having removed the sealing putty from sealing cap 31 (Fig.4) and having unscrewed two screws 32 securing housing 8 to supports 53. Partial disassembly of the overload warning unit is allowed to be carried out after the guaranteed period of the instrument service life has expired.

To effect a complete disassembly of the overload warning unit:

1. Remove the sealing putty from cap 31, unscrew two screws 32 and take out housing 8.

2. Unsolder the wires connecting plug connector 47 to the leads of collectors 66 and 75 and of blocks 52 and 64. This done, proceed to unsolder current-conducting spring 45 from the leads of blocks 50, 52 and 67.

3. Drive two supports 53 from cover 36, unscrew screws 51, 63 and 71, and separate blocks 52 and 64, angle piece 62 with collector 66 and block 69 with parts from cover 36.

4. Unscrew screws 65 and separate collector 66 from angle piece 62.

5. Unscrew screws 48 and 73, and take collector 75 away from angle piece 74; this done, separate the angle piece mentioned from block 69, and drive screw 41 and nut 42 from block 69. When taking away cover 36, angle piece 62 and block 69 with the components attached, take care not to damage contact brushes 43.

6. Drive screw 72 from strip 70.

7. Unscrew three screws 37 and separate the unit of the sensitive element from cover 36.

8. Separate springs 6 (from blocks 7 and 9) and strips 57, having unscrewed three screws 58.

9. Drive out screws 25 and separate strips 49, 68 and 70 from weight 1.

10. Separate copper sleeve 24 from weight 1 having unscrewed screws 26.

11. Detach strips 56 from weight 1 by unscrewing screws 55.

12. Drive screws 39 and take brush holders from blocks 50 and 67. Do not disassemble the unit of the brush holder.

13. Drive out screws 44 and detach blocks 50 and 67 from strips 49 and 68.

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14. Unscrew four screws 54 and detach cover 36 with the magnetic system from body 19. Do not disassemble the magnetic system.

15. Take rubber gasket 12 from body 19 and strip 11, having driven out two screws 10.

16. Take clamps 60 off screws 61, having previously unscrewed nuts 59, and detach the wires from the body walls.

17. Detach plug connector 47 with cables and sheathing coat 27 from body 19, having driven out nut 16 and taken away sealing wedges 13.

18. Turn out three screws 2 and separate bushing 3 from housing 8.

C. Assembly

Clean the parts to be assembled so that they exhibit no evidence of nitrovarnish, glue and corrosion.

Assemble the instrument adheroring to the following procedure:

1. Assemble blocks 50 and 67 to strips 49 and 68 with the aid of screws 44.

2. Assemble weight 1 to springs 6, clamp it with the aid of strips 56 and secure with screws 55.

3. Attach sleeve 24 to weight 1 by means of four screws 26. Apply glue БФ-4 to screws 26, and liquid bakelite, to all other screws.

4. Insert strips 49 and 68 with the blocks into the slots of copper sleeve 24 and lock strip 70 with screws 25.

5. Assemble springs 6 with blocks 7 and 9 and strip 57, and secure the unit assembled with the aid of three screws 58.

6. Pass insulation-protected wires into the hole of body 19, insert sealing wedges 13 and tighten nut 16. Press the cables to the walls of body 19 making use of two clamps 60, four screws 61 coated with glue БФ-4 and nuts 59.

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7. Place the magnetic system inside body 19, pass the cables through the hole on cover 36, and secure the unit of the magnetic system with the aid of four screws 54.

8. Attach rubber gasket 12 to body 19 using glue No.88, secure the gasket with strip 11 and lock with two screws 10.

9. Fix the unit of the sensitive element to cover 36 with the aid of three screws 37 taking care to ensure free (i.e. withou jamming) travel of sleeve 24 within the clearance of the magnetic system.

10. Drive screw 72 into strip 70, seeing that the former enters into the latter without play. Upsetting of strip 70 is considered permissible.

11. Secure blocks 52 to cover 36 by screws 51.

12. Attach collectors 66 and 75 to angle pieces 62 and 74, respectively, with the aid of screws 65 and 48.

Prior to assembling, the collectors must be washed in special grade of gasoline (called "KALOSHA").

13. Secure angle piece 74 with the collector to block 69 making use of two screws 73.

14. Turn nut 42 onto screw 41 and drive the screw into block 69.

15. Make use of screws 63 and 71 to secure block 69 with its components and angle piece 62 with collector 66 to cover 36, and turn in two supports 53.

16. Arrange the cables in conformity with Figs 3 and 4. Solder current-conducting springs 45 to the leads of blocks 50, 52, 64 and 67. Wash the soldering joint with alcohol and coat with insulating varnish.

17. Fit contact brushes 43 in the sensitive element unit having previously locked them with the aid of two screws 39.

18. Insert bushing 3 into the hole made in housing 8 and fix the bushing by means of three screws 2.

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19. Protect the instrument with housing 8 and secure it with two screws 32. Set sealing cap 31 under one of the screws.

20. Screw nut 5 onto bushing 3 and lock it with screw 33.

The overload warning unit having been assembled, check the insulance of the electrical components as instructed under Para.B, Section V, and carry out the necessary adjustment.

D. Adjustment

Adjustment of Contact Pressure and Checking Contact Reliability

Proceed to perform the necessary adjustment having removed housing 8 (Fig.4).

1. Turning bushing 38 of the contact in block 50 (67), move brushes 43 off collector 66 (75). This done, carefully wipe the collector with a dry piece of cloth, and the brushes, with a piece of cloth wetted in alcohol.

2. Bring the brushes toward the collector and lightly press them in.

3. Connect the overload warning unit to the oscillograph (Fig. 8).

Note: The warning unit is provided with two collectors joined parallel to each other, so one pair of the brushes should be isolated, when connecting the warning unit to the oscillograph.

4. Employing a grammeter, catch the bent ends of the brushes and move them off until the circuit has been broken (the sine curve being broken on the screen of the oscillograph and a straight line taking its place).

5. If the contact pressure of the brushes is other than 2 ± 0.5 gr , ease on screws 39 and adjust the contact pressure.

Measure the value of the contact pressure several times to make sure the adjustment has been done the proper way.

Check the contacting reliability smoothly shifting the sensitive element (weight 1) by hand throughout the whole range of its travel. Check the signals of 1.6 g and 2 g (terminals 1-2 and 1-3 of the plug connector) separately.

Note: Check the contacting reliability making use of a tester, or an ohmmeter whose scale is graduated in terms of ohms.

Determination of Reduced Weight of System

1. Set the rotating unit in a strictly horizontal position.
2. Install overload warning unit 4 on the rotating unit, attach contact 2 to it and rotate through 180° (Fig.9,a). This position of the overload warning unit corresponds to an overload of 1 g.
3. Rotating micrometer screw 6, bring it toward contact 2 attached to the weight of overload warning unit 4 until the former touches the latter, i.e. until electric lamp 1 has gone on.
4. Set the overload warning unit to its original position (Fig.9, b). This position of the instrument corresponds to an overload of +1 g.
5. Fix stud 5 to pan 8 via pulley 3.
6. Load weights 7 on the pan until the latter touches contact 2 and micrometer screw 6, i.e. until electric lamp 1 has gone on (starts flickering).
7. Determine the reduced weight of the system on the basis of the following formula:

$$P_r = \frac{(\text{weight of weight set+pan weight})-2\ \text{weights of stud with strip}}{2},$$

where: p_r is the reduced weight of the system expressed in gr.

The permissible error involved when determining the reduced weight must not exceed 0.5 gr.

The device for determining the reduced weight is shown in Fig.10.

Adjustment of Overload Warning Unit on the Basis of Its Operation Data

1. Making use of level 1 (Fig. 6), adjust base plate 2 setting its upper and lower surfaces in the horizontal position, and mount the warning unit onto the base plate.

2. Connect the warning unit to power plant 5. The connection diagram is shown in Fig.7.

3. Screw calibrating unit 3 (Fig.6) into the threaded hole made in the weight, and place set of weights 4 onto the calibrating unit.

4. Determine the weight of the set of weights in the following way:

- $p_1 = p_o \cdot 0.6 - p$;
- $p_2 = p_o - p$

where: p - weight of the calibrating unit;

p_1 - weight of the weight set under 1.6 g overload;

p_2 - weight of the weight set under 2 g overload;

p_o - reduced weight of the whole system expressed in gr.

The overload warning unit is considered well adjusted, if the lamp of the power plant starts flickering upon placing the weight on the calibrating unit.

If the electric lamp glows but does not flicker or does not go on at all, ease on screws 65 and 73 (Fig.4) and apply a screw-driver pressure to raise or lower collectors 66 and 75.

4. Tighten all the screws and coat them with glue БФ-4 with colouring agent.

Determine the errors of the warning unit seeing that they do not exceed the permissible limits (See Para. 4 of Section II).

Tools Necessary for Disassembly, Assembly and Adjustment of Overload Warning Unit

1. Fitter's screw-driver.
2. Watchmaker's screw-driver.
3. Tweezers (or pincers)
4. Soldering irons.
5. Pliers.
6. Wrenches.

VII. PACKING, STORAGE, AND SHIPPING

A. Packing

Wrap every warning unit up in cardboard or parchment paper and arrange in corrugated cardboard container.

Note: Brown paper or coarse wrapping paper may be used instead of the foregoing grades of paper.

Put the calibrating unit (one per four warning units), stop and Certificate in every packing container.

Making use of water-repellant glue, attach a label to the outer side wall of the packing container specifying:

(a) name and model of the warning unit, and its main characteristics;

(b) serial number of the warning unit;

(c) date of manufacture;

(d) packer's number;

(e) Certificate number;

(f) seals (of the consignor and consignee);

(g) storage period requiring no checks.

Arrange the containers with the overload warning units in a strong box lined with bitumen paper or tar-impregnated paper inside. Place the containers with the warning units inside the box close to one another so that they do not move while being shipped. Pack the gaps between the containers with dry wood shavings.

Using indelible paint, mark the following stencils on the outer side walls of the packing box: "HANDLE WITH CARE", "INSTRUMENTS", "DO NOT TIP" (ОСТОРОЖНО, НЕ БРОСАЙТЕ, НЕ КАНТОВАТЬ) and on the cover of the box: "THIS SIDE UP", "OPEN THIS WALL", (ВЕРХ, ВСКРЫВАТЬ ЗДЕСЬ), addresses of the consignor and the consignee. Bind the box with band iron and put stamps of the Manufacturer and of the representative of the consignee. Insert a packing sheet in every box specifying the components placed therein. Wrap the envelope containing the packing sheet with waterproof paper.

The gross weight of the box must not exceed 50 kg.

B. Storage

Keep the overload warning units packed in the packing containers in well heated and aired depots under temperatures ranging between +10°C and +30°C and the relative humidity between 40 and 70%. Sharp fluctuations of the temperature and the humidity are not permissible.

The premises the warning units kept in should be thoroughly protected against penetration of various kinds of gases (chlorine, vapours of ammonia, smoke and the like). It is absolutely inadmissible that chemicals, acids, and alkalies should be kept in the depots together with the overload warning units.

Arrange the warning units on special racks made of wood whose relative moisture content does not exceed 20%. The racks must stand at least 40 cm. off the walls and the floor of the

depot and provided with cloth blinds for protecting the overload warning units from deteriorative effect of the dust and rays of the sun. If long-term storage is expected, uncage the overload warning units and stop the hole made on the housing with the aid of a nut.

C. Shipping

Before shipping the overload warning units, cage them as indicated in Section III and in the Certificate accompanying the instrument.

The containers with the overload warning units should be shipped in strong boxes protected against moisture.

While shipping, protect the boxes against the deteriorative effect of snow and rain (at railway stations, quays, and on cars) covering them with tarpaulin.

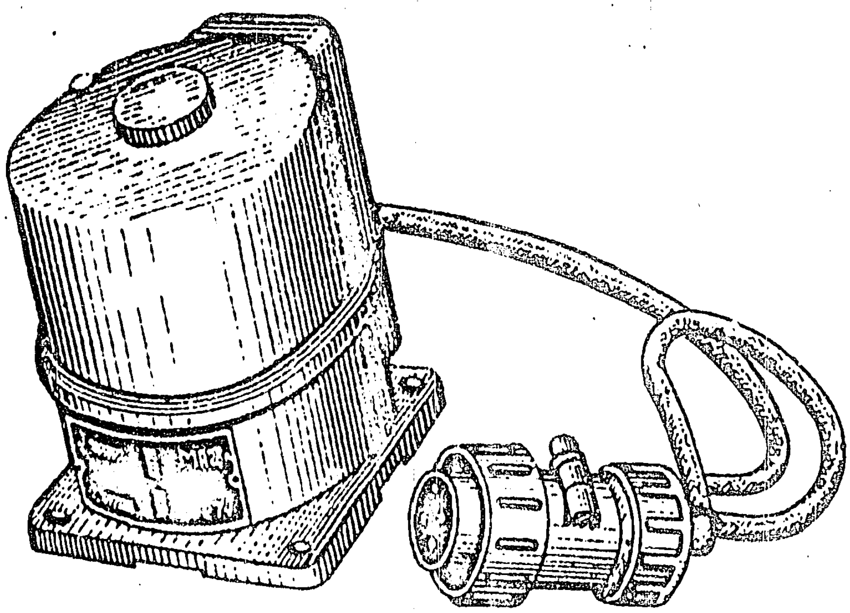

Fig. 1 Overload Warning Unit MП-28A. General View

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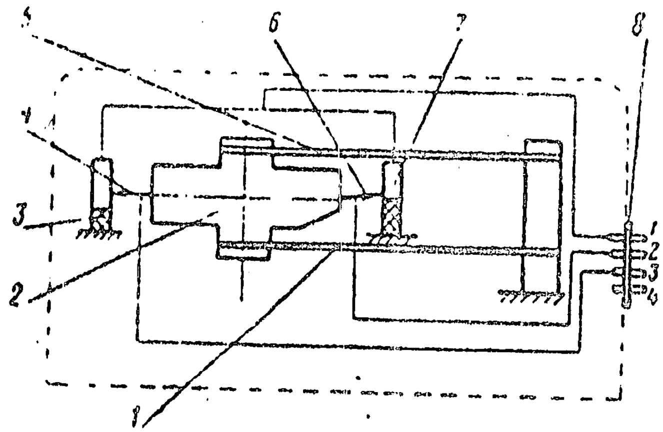

Fig. 2. Schematic Diagram of Overload Warning Unit

1, 5 — springs; 2 — weight; 3, 7 — collectors; 4, 6 — contacts with brushes; 8 — plug connector.

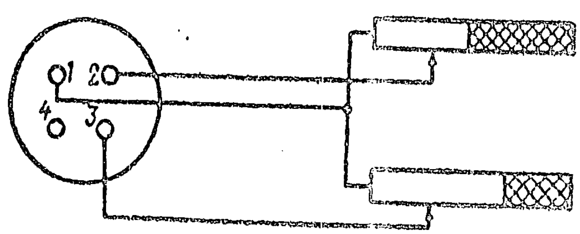

Fig. 3. Circuit Diagram of Overload Warning Unit

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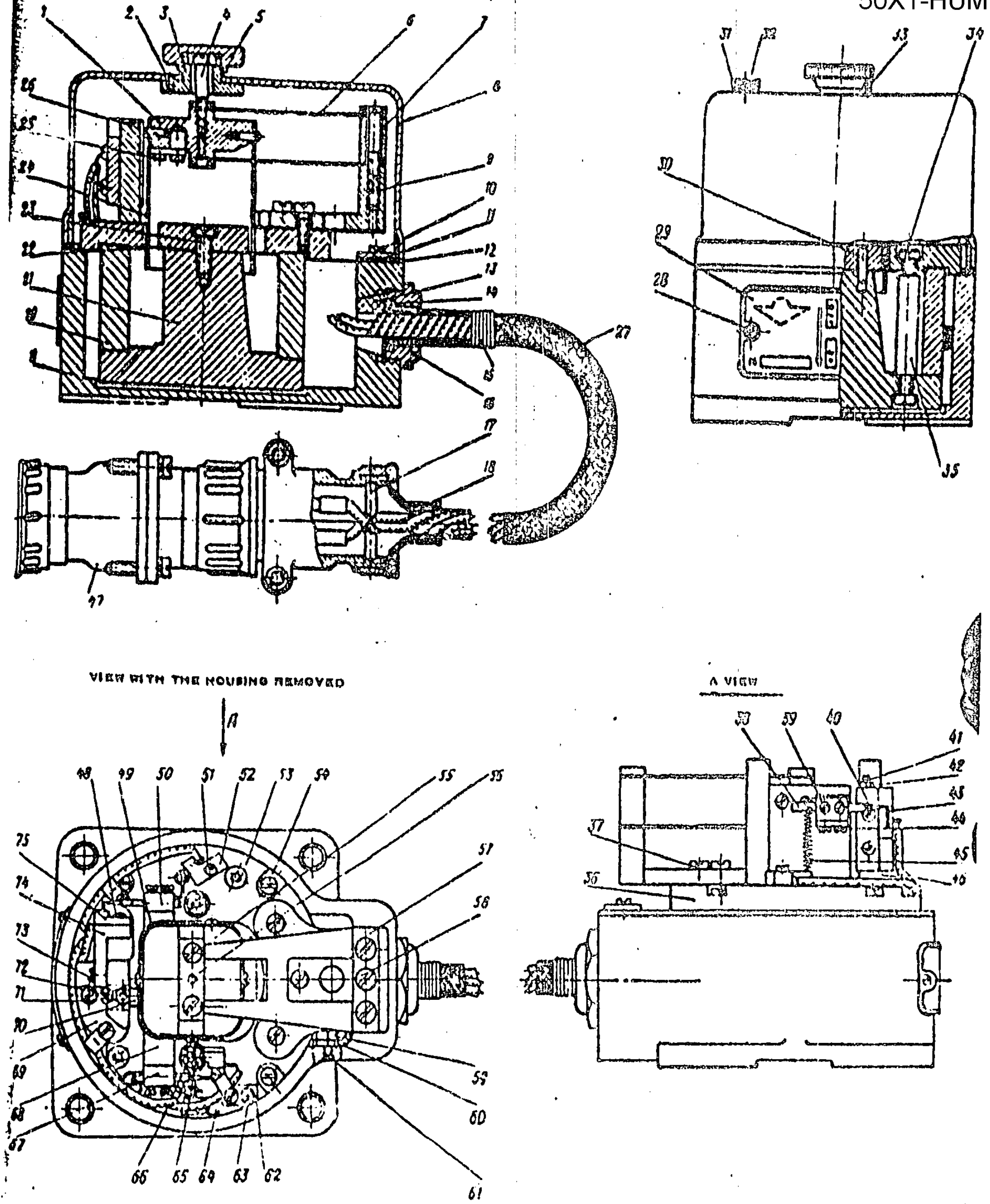

Fig. 4. Cut-Out and Sectional Views of Overload Warning Unit

1 – weight; 2, 10, 23, 25, 26, 28, 32, 37, 39, 41, 44, 48, 51, 54, 55, 58, 61, 63, 65, 71, 72, 73 – screws; 3 – bushing; 4 – stop; 5, 16, 34, 42, 59 – nuts; 6 – spring; 7, 9, 30, 52, 64, 67, 69 – blocks; 8 – housing; 11, 49, 56, 57, 68, 70 – strips; 12 – rubber gasket; 13 – sealing wedge; 14 – washer; 15 – spring; 17 – pin; 18 – cap; 19 – body; 20 – magnet; 21, 22 – cores; 24 – sleeve; 27 – sheathing coat; 29 – name plate; 30 – lockpin; 31 – sealing cap; 33 – locking screw; 35 – support; 36 – cover; 38 – bushing; 40 – pipe; 43 – contact brushes; 45 – spring; 46 – cables; 47 – plug connector; 53 – support; 60 – clamp; 62 – angle piece; 66, 75 – collectors; 74 – angle piece.

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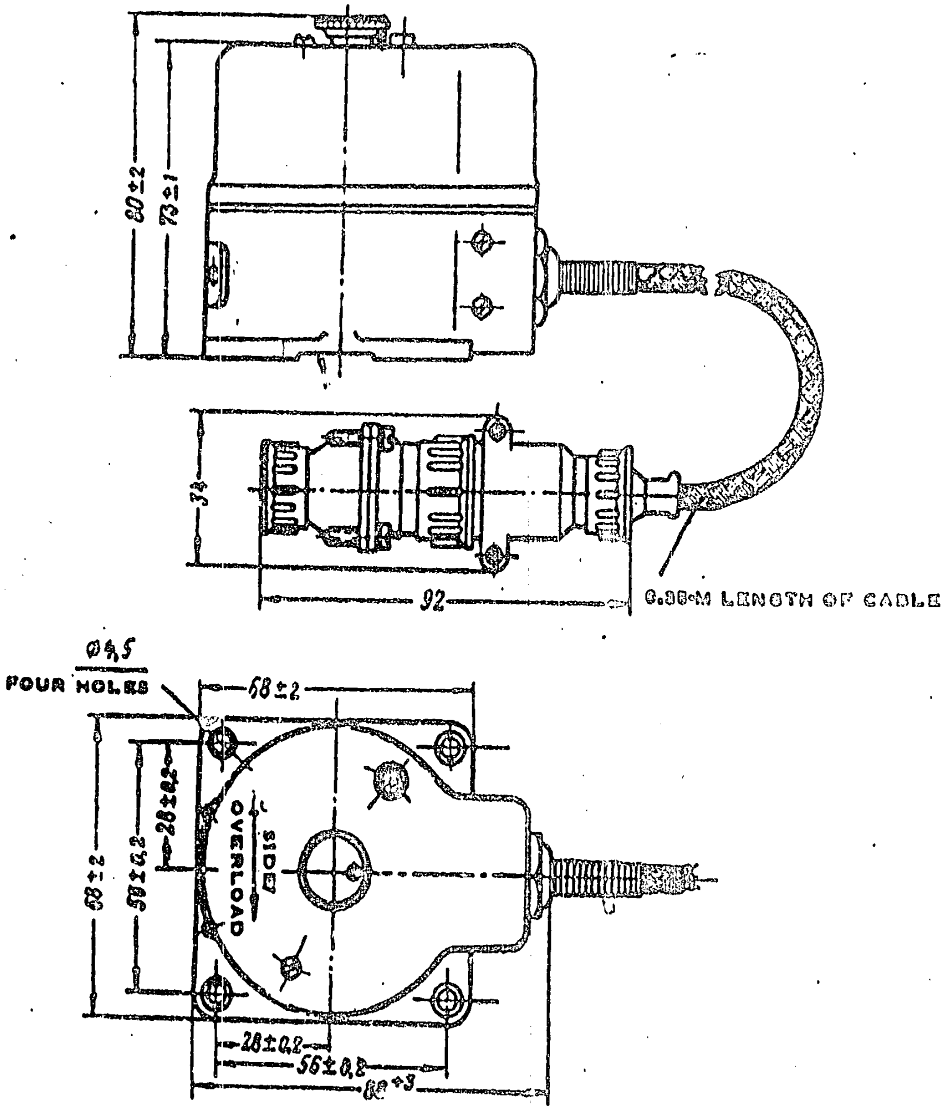

Fig. 3. Dimensions Diagram of Overload Warning Unit

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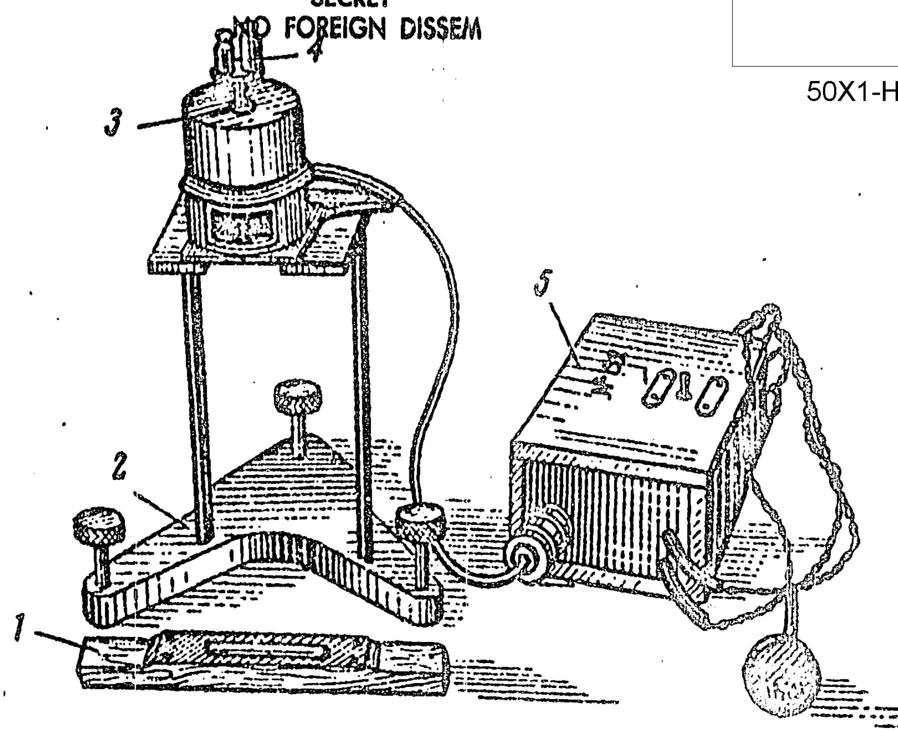

Fig. 6. Checking Equipment for Measuring Errors and Adjusting Overload Warning Unit According to Its Operation Data

1 — level; 2 — base plate; 3 — calibrating unit; 4 — set of weights; 5 — power plant.

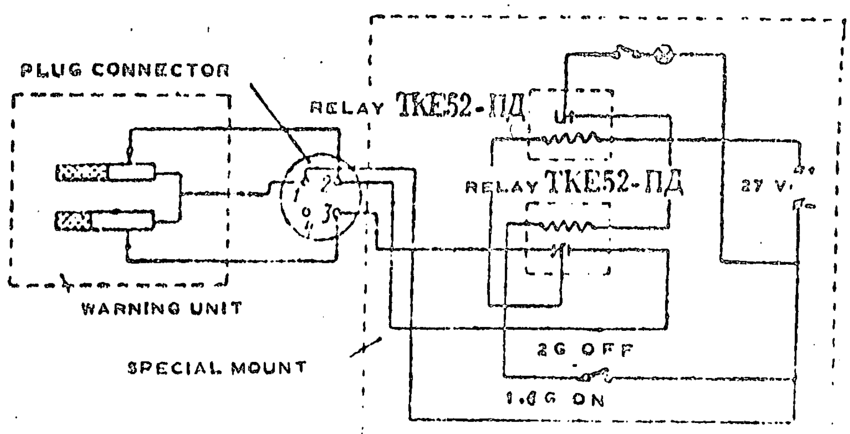

Fig. 7. Circuit Diagram for Connecting Warming Unit to Power Plant

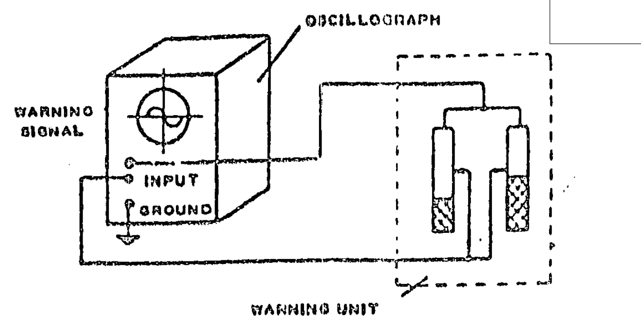

Fig. 8. Circuit Diagram for Connecting Warning Unit to Oscillograph when Checking for Contacting Reliability

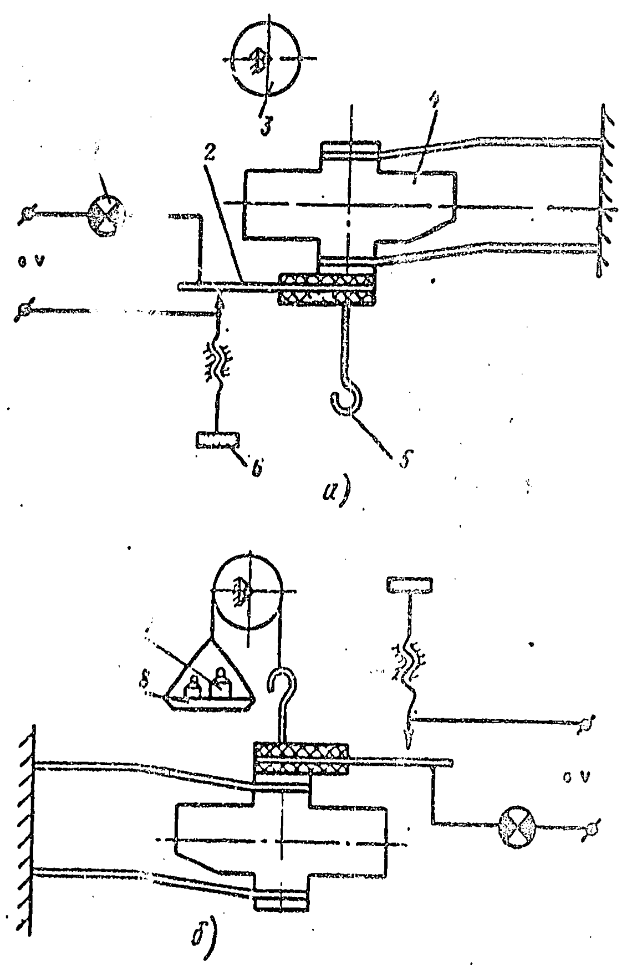

Fig. 9. Diagram of Unit for Determining Reduced Weight

1 – electric lamp; 2 – contact; 3 – pulley; 4 – warning unit; 5 – stud; 6 – micrometer screw; 7 – set of weights; 8 – pan.

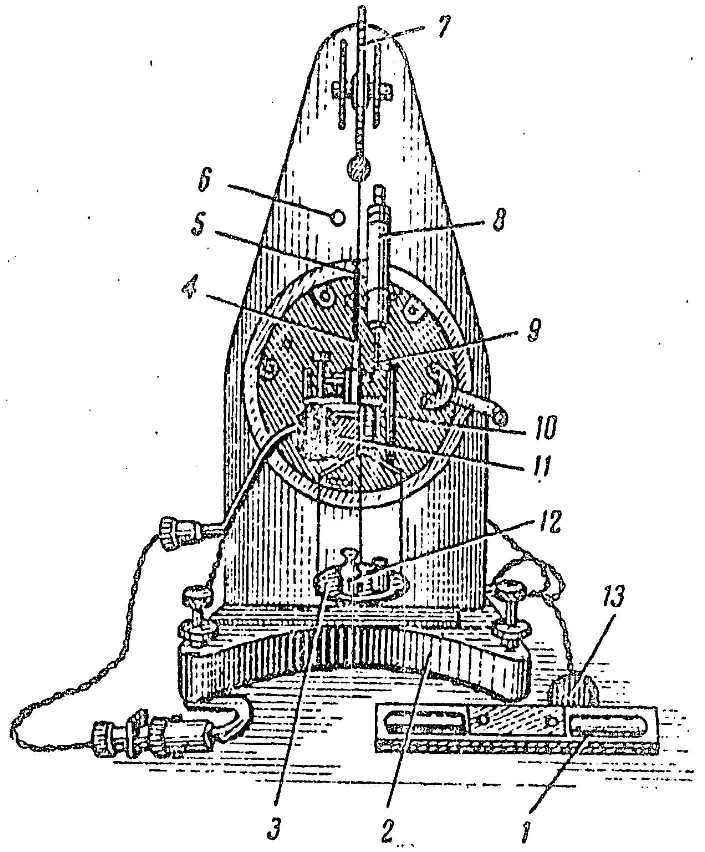

Fig. 10. Unit for Determining Reduced Weight. General View

1 – level; 2 – rotating device; 3 – pan; 4 – stud; 5 – hook; 6 – warning lamp; 7 – pulley; 8 – micrometer screw; 9 – contact; 10 – screw; 11 – warning unit; 12 – set of weights; 13 – connector plug.

Сигнализатор перегрузок
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